UiT The Arctic University of Norway

Department of Clinical Medicine

The Faculty of Health Sciences

Co-creating since 1990s: an qualitative analyses of the exploratory case study on a small private health IT company in North Norway though the prism of ANT.

Vitalii Ikoev

Master's thesis in Telemedicine and E-health. TLM – 3902

May 2020

Foreword

This thesis is submitted as a final delivery to fulfil the requirements for the degree in Master of Science in Telemedicine and E-Health at the Faculty of Health Sciences department of Clinical Medicine, University of Tromsø, Norway.

This thesis is a result of an inspiring journey to the North of Norway, getting in contact with incredible people and diving deep into the world of ehealth and telemedicine. The thesis is all about people and the human side of technology, as I believe that people change the world, not IT.

I would like to thank my supervisors Gunnar Ellingsen and Kari Dyb for professional and general support and guidance throughout my studies and process of thesis writing. I am thankful to meet great people whom I got to know and interviewed in the vendor-company. You all are my role models and I learned a lot from every single one of you. I am forever grateful for having the opportunity to get to know everyone who was part of the Master studies in Telemedicine and E-Health, main and invited professors, researchers and students.

I dedicate this master thesis to my wonderful granny, who passed away right before I started my studies in Tromsø.

Vitalii Ikoev

The Arctic University of Norway.

Tromsø, Norway

May 14th, 2020.

Abstract

Background: Digitalization of healthcare is done through development and delivery of health information technology, mobile health, wearable devices, telehealth, telemedicine, health portals, personalized medicine, or in other words – ehealth. Ehealth solutions are expected to improve the treatment process, improved safety, efficiency and quality, as well as empowerment of both patients and healthcare professionals. However, enthusiasm around technological innovation around e-health has not always been matched by uptake and utilization in practice. The amount of research on ehealth has been increasing last years, but there is little attention in research on how health IT solutions are being developed. There is a need for new knowledge on how vendors approach and work when developing solutions.

Aims and objectives: In order to gain new knowledge on how a small vendor approached the development of e-health solutions in Norway, the rational choice was to address the experience of a private ehealth software vendor with 6 employees and established in year 2000, with pre-history from 1990s and located in North Norway. The goal of this study is not to evaluate the vendor or if the development as successful/failed or get into the technical details. The mission is to investigate empirically how the employees of a small vendor-company in Norway perceive the development of the solutions, explore and describe the process. The overall aim is to add to a new empirical understanding of the processes in e-health solutions development.

Methods: The data was collected through conducting interviews using qualitative exploratory case study was used for this study. The obtained data was analysed through the prism of Actor-Network theory, socio-technical approach and keeping in mind the Software Development Models.

Results: The research showed that co-creation with end-users was a natural part of the development process and was a necessary approach along with the unique context of the location of the vendor, it's stakeholders, workflow challenges, enthusiasm and agility in development.

Conclusion: This master thesis illustrates how a small vendor in North Norway continued to carry on the established user-involvement practices and worked in very close cooperation with clinicians in the solutions development process for years starting in1990s.

Keywords: co-creation, software development, user-involvement

List of abbreviations

ANT	Actor-Network Theory
EHR/EMR	electronic health/medical records
HIT	health information technology
HCD	human-centered design
IT	information technology
ICT	Information and communication technology
mHealth	mobile health
PACS	picture archiving and communication system
PC	personal computer
R&D	research and development
RiTø	Regionsykehuset i Tromsø / Regional Hospital of Tromsø
RIS	radiologisk informasjonssystem / radiology information system
SDLC	Software Development Life Cycle
UCD	user-centered design
UNN	Universitetssykehuset Nord-Norge

Table of Contents

1 Introduction 6
1.1 Background 6
1.2 Aim of the study 7
1.3 Research question 9
2 Theory 10
2.1 Socio-technical approach 10
2.2 Actor Network Theory 12
2.3 Software development models 15
2.4 Software development in healthcare. 19
3 Method 22
3.1 Design and approach 22
3.1.1 Research design 22
3.1.2 Qualitative research 22
3.1.3 Exploratory case study 23
3.2 Data collection 25
3.2.1 Gaining access 25
3.2.2 Participants and recruitment process 26
3.2.3 Document analyses. 27
3.2.4 Interviews 27
3.2.5 Data Analyses 30
3.3 Reflections on the method 31
3.3.1 Researcher role and quality 31
4 Findings 34
4.1 Region hospital 34
4.2 Workflows. 35

4.3 High motivation and competence. 38
4.4 Being effective, Agile and build MVP as a core principle 40
4.5 Multidisciplinary team. 41
4.6 Co-development 43
4.7 Keeping the close contact with customers 45
4.8 Training and continuous feedback 46
4.9 Keeping the old traditions that work 47
5 Discussion 48
5.1 Location 48
5.2 Agile and Design Thinking 49
5.3 Co-creation and user-involvement. 50
6 Conclusion 54
7 Limitations 56
8 Literature 57
Appendix 67

List of Figures

Figure 1 - Waterfall model. 16
Figure 2 - Iterative model. 17
Figure 3 - Spiral model. 18
Figure 4 - V model. 18
Figure 5 - Agile model. 18
Figure 6 - The human-centered design approach. 21
Figure 7 - Radiology workflow in Tromsø University Hospital. 36

1 Introduction

1.1 Background

Digitalization involves a rapid implementation of technology into various parts of healthcare services and practices (Konttila et al., 2018). Digitalization of healthcare is done through development and delivery of health information technology (HIT), mobile health (mHealth), wearable devices, telehealth, telemedicine, health portals, personalized medicine, or in other words - ehealth (Drosatos, Kavvadias, Kaldoudi, 2017; Konttila et al., 2018). It is a growing area and is supported by use of digital communication and information technology (IT) for keeping, sending and receiving of data for administrative, scholar and clinical purposes (Ahmed, Dannhauser & Philip, 2018). Ehealth is a broad term and includes a wide variety of solutions such as simple forums, digital support groups or complex electronic health/medical records (EHR/EMR), personal mobile and virtual reality applications, big data health systems etc.(Ahmed, Dannhauser & Philip, 2018).

Benefits of ehealth are including information sharing among different departments, updated health-related information, clinical decision support systems, improved administrative system and effortless maintenance of hospital services (Zayyad & Toycan, 2018). Ehealth solutions are expected to solve problems coming along with ageing population and limited resources, at the same time improving the treatment process (Ross et al., 2016). Improved safety, efficiency and quality, as well as empowerment of both patients and healthcare professionals is also associated with benefits brought by ehealth (Greenhalgh et al., 2018).

However, enthusiasm among developers, policymakers and politicians around technological innovation around e-health has not always been matched by uptake and utilization in practice (Mair et al., 2012; Konttila et al., 2018). The evaluation of the impact of ehealth technologies shows the deviation between the expected benefits and real outcomes (van Gemert-Pijnen et al., 2011; Sligo, Gauld, Roberts & Villa, 2017). A significant amount of ehealth interventions are not considered as successful during clinical implementation. Moreover, clinical practice may not be improved despite the promising theoretical research results (Granja, Janssen & Johansen, 2018).

E-healthcare in Norway seems to have some potential to play a significant role in healthcare delivery. 5.2 million citizens are unevenly spread over a big country, which stretches over 2000 kilometres from south to north with a 25000 km coastline and thousands of islands and mountains (Norden.org, 2020). Add to this a rough climate and these conditions bring logistical challenges for the provision of health care. Use of information and communication technology (ICT) in healthcare, therefore, is seen as a potential solution to this problem, being a background for the development of ehealth and telemedicine in Norway. Therefore, IT is recognized as an important aspect for achieving health policy targets (Myrvang & Rosenlund, 2007).

The amount of research on ehealth has been increasing last years (Liu, Su & Ji, 2019). Topics like uptake of different eHealth solutions/technologies/digital tools, clinical effects of ehealth, usability and satisfaction for health care providers and patients' have been an emphasis of e-health research (Son, Jeong, Kang, Kim & Lee, 2015; Gemert-Pijnen, Kelders, Kip & Sanderman, 2018; Liu, Su & Ji, 2019). But there is little attention in research on how health IT solutions are being developed. There is a need for new knowledge on how vendors approach and work when developing solutions. So why not shift our focus from outcomes of the ehealth technology and its effect on healthcare and healthcare work, and have a look at how ehealth solutions are being created?

Therefore, this master thesis is focusing on the healthcare vendors' perspective. Considering the little known on the supply-side of the ehealth solutions, I find it interesting to investigate:

- *how do private health IT companies in Norway approach the development of hospital/clinical ehealth solutions in the context of the Norwegian healthcare sector?*

1.2 Aim of the study

In order to gain new knowledge on how a small vendors approached the development of e-health solutions in Norway, the rational choice was to address the experience of a private ehealth software vendor, located in Northern Norway and delivering the solution for hospitals.

The vendor-company chosen for this case started its operation in the northern part of Norway, that is known for smaller population density and larger distances between inhabitants and healthcare facilities. Therefore, the chosen vendor operates in an environment and context when it comes to supporting the delivery of care at a distance, that is a basic principle behind ehealth.

The vendor further developed and maintained a local solution for radiology professionals in UNN that afterwards was used in other regions in Norway and Europe. The Regional Hospital of Tromsø (RiTø) back then (now - UNN) stands out due to the fact that it was among the very first hospitals in Europe to offer the North Norwegian population health IT services back in 1992 (Hartvigsen et al., 2007; Hurlen, 2012).

Vendors solution had existed on the market for about 20 years, but the history of the product development started way before it took form as a commercial project with pioneering efforts of healthcare professionals at the hospital (Hurlen, 2012). The company was operating within e-health industry for almost two decades, meaning that informants can reflect not only on how things are being done now but also how it was done many years ago, when technology, market, workflow, processes, practices and the digitalization of the hospital, IT literacy and use of technology at work and personal life have been on another level and had another context.

Access to ehealth vendors might be even more challenging, as there are few e-health vendors, and one vendor can serve several healthcare institutions with its solutions. As the competition is high in the technological industry, with more start-ups coming to the market, the access to research an e-health vendor can become even more complicated.

The abovementioned facts concerning the vendor, hospital and region as a context is the unique opportunity to study this particular case and examine the question that is relatively poorly covered by the research. Therefore, having this vendor as a case is expected to be an opportunity to investigate the research question in a real company that existed nearly 20 years, rather than experimental settings. This makes it even more interesting to be able to study the vendor that was delivering services to on a front in digitalisation of healthcare services. It involves analyses on a micro level and is interested in the opinion and views of a certain group of stakeholders, namely people involved in developing the e-health solutions for healthcare professionals. Therefore, an explorative case study is considered as a relevant research design.

Insights from science and technology studies will be used to inform the empirical study of solution development, looking at it through a socio-technical perspective. It is clear that the interplay between technologies, work/workforce and organisational context is important to the implementation, use and non-use of digital technologies (Harrison, Koppel & Bar-Lev, 2007). Sociotechnical approach has interconnected the social and technical aspect even closer. In addition to the people involved, these heterogeneous networks consist of constitutive elements

and tools like organizational routines, documents, information systems, buildings, distances and so on (Berg, 1999).

The goal of this study is not to evaluate the vendor or if the development as successful/failed. The focus is not to get into the technical details either. The mission is to investigate empirically how the employees of a small vendor-company in Norway perceive the development of the solutions, explore and describe the process. The overall aim is to add to a new empirical understanding of the processes in e-health solutions development. This makes investigating the e-health software development from a vendor perspective in a taken region highly relevant and interesting. The selected vendor is a small company with 6 employees and established in year 2000 and located in North Norway.

1.3 Research question

The research question for this study is:

- how a small private health IT company approached the development of clinical ehealth solution in the context of the Norwegian healthcare digitalisation?

2 Theory

When conducting research on ehealth, researchers often conduct evaluation. As the evaluations become more common with more ehealth solutions being developed and implemented, evaluation becomes a prevalent approach. The purpose of ehealth evaluation is to thoroughly collect information that can be used to explore the general effectiveness and quality of an eHealth technology (Gemert-Pijnen, Kelders, Kip & Sanderman, 2018). However, this master thesis is not a pure evaluation, but rather focuses on identifying, exploring, investigating, analysing the role of the network that stakeholders and even the whole network played in the vendor's solution development process.

2.1 Socio-technical approach

Interrelation between technology and its social environment plays a central role in understanding ehealth development, due to the fact that information systems require interaction with people. Limited uptake of eHealth in clinical practices calls for different viewpoints. Therefore, importance of incorporating insights from the social sciences is increasingly accepted, especially within medical informatics, as well as informatics and information systems (van Gemert-Pijnen et al., 2011; Berg, Aarts & van der Lei, 2003). Sociotechnical approaches aim to obtain a better understanding of how electronic communication or information systems are developed, implemented and become a part of social practices (Berg, Aarts & van der Lei, 2003).

Socio-technical approach is presented in the theoretical approach in research such as Actor-Network Theory (ANT). Its development started in the sociology of science and technology, as the impact technology on society and vice-versa started to be a major topic of discussion (Law, 1992). B. Latour (1991) states that the separation of the social and technical was troublesome because a non-human element was a key factor for the relative durability of a "stable" social relation (Latour, 1991).

The sociotechnical approach is one which seeks to recognize the interrelation and influence between technology and the social, professional and cultural environment in which it is used. Therefore, the way researchers see the way how those ICT systems are developed in the first place is greatly affected by the healthcare employee-ICT interaction. M. Berg (1999) suggests

that the socio-technical approach in recent years has shifted focus from isolated development to a more user-involved approach: "embracing a user-oriented perspective, a sociotechnical approach emphasises that an in-depth insight into the settings where the systems are to be used should be the starting point for the design and implementation of these systems" (Berg, 1999).

Today's health organisations are complex, including many interdependent and interrelated technical and social elements. This complexity means that changes to one part can create a "butterfly effect", affecting some other parts of the organisation and the network of healthcare delivery as a whole (Plsek & Wilson, 2001; Benson, 2005). For example, the introduction of a new technology into a given setting can lead to innovation in clinical roles, work processes, and culture change. However, the attitudes and use of technology is socially shaped, and uptake of the new technology can vary. Changing, eliminating, scaling or including new tools can entail consequences that might reverberate throughout the whole of the organization (Berg, 1999). The process of protecting the health of a patient is often done through a joint effort of many healthcare professionals within multiple healthcare disciplines. With the introduction of a new technical system, one must be careful with interconnection between the system and a work environment in which it exists. There is a great chance that each change in IT will may have widespread consequences for that work practice. (IAMOT 2018 Conference Proceedings, 2018). This view is supported by Bannon and Schmidt (1989) who states that “by changing the allocation of functions between humans and their implements, changes in the technology induce changes in the organization” (Bannon & Schmidt, 1989). Workers’ roles and the relationship between them are created within these diverse networks. It is however not easy to describe or give pre-set specifications to the objects in these networks. Features, functions and roles are discussed and obtained only as a part of that specific network (Berg, 1999). It is not possible to distinguish a specific set of only technical or social problems that may arise when designing or implementing new systems. This simply has too unpredictable, compound and complex nature. For example, possible unplanned consequences mapped out by Ash et al. is increase in the number of work-related tasks for the users and interruption of pre-established smooth workflows and communication practices (Ash et al, 2007). Therefore, IT solutions and systems are suggested not to be viewed as separated entities within their expected clinical environment. Instead, systems are always interacting and cooperating with the clinical staff and organisational routines, as well as the clinical team (Bannon & Schmidt, 1989).

Socio-technical approach suggests that people, context and technology are needed to create ehealth technologies that are of added value for the stakeholders and the context in which they

are implemented. Just creating or coding a solution is not sufficient when it comes to eHealth development: it also includes creating and evaluating an infrastructure for knowledge distribution, communication and the organization of healthcare delivery. This holistic approach plays a crucial role not only in eHealth development but also in evaluation. Therefore, eHealth developers, policy makers and researchers should be aware of the stakeholders' impact from technology. In the case of a healthcare organization their (social-cultural) context should also be taken into consideration. Addressing the interconnection between the users, the technology and the context is therefore key in gaining insight into the impact a technology has during evaluation. This indicates that a comprehensive picture can almost never be obtained by conducting a single evaluation method used to study technology. A mixed-methods approach should therefore always be considered (Gemert-Pijnen, Kelders, Kip & Sanderman, 2018).

This holistic approach is supported in ANT that is described more in details in the next paragraph.

2.2 Actor Network Theory

Studying e-health requires different social theories than those that were introduced to us before. The reality needs to go through a process of simplification, but it should not be done to the gradation that this covers the nuances and details that are actually describing this complexity. K. Cresswell and colleagues (2010) suggest to acknowledge the challenge and pay attention to several paths showing different stories. Those stories may be interconnected. It is done in order to get insights into aspects of the complex picture one is studying by finding those relations between various stories/worlds (Cresswell, Worth & Sheikh, 2010).

With an increasing volume of computerization of the healthcare industry, technologies and organizations become ever more complex. Therefore, relationships between humans and objects need a more comprehensive view, and this need is clearer than ever. In this context, radical approach of ANT theorising the relationships between humans and objects has become a catalyser of academic debates (Cresswell, Worth & Sheikh, 2010).

Hanseth and Monteiro explains the idea of Actor Network Theory (ANT) in their own way:

> *When going about doing your business - for example driving your car - there are a lot of things that influence how you do it. For instance, when driving a car, you are influenced by traffic regulations, prior driving experience and the car's manoeuvring*

> *abilities. All of these factors are related or connected to how you act. You do not go about doing your business in a total vacuum but rather under the influence of a wide range of surrounding factors. The act you are carrying out and all of these influencing factors should be considered together. This is exactly what the term actor network accomplishes. An actor network, then, is the act linked together with all of its influencing factors (which again are linked), producing a network"* (Hanseth & Monteiro, 1998, p.96-97)

ANT has been used to the study of innovations in and outside healthcare settings. The result of those studies were crucial insights, exploring the active role of technological innovations in forming social processes in complex environments. ANT is taking advantage from socio-technical approach. In doing so, its most radical notion is that things and objects, for example technologies, are "actants" and therefore have the potential to transform and facilitate social relationships. ANT helps to theorize how different actors experience and behave in various realities. This helps to consider the relations between different actors and get a more comprehensive picture of their dynamic interactions. Rapid-moving and ever-changing area of healthcare itself makes the attention to interrelations and details more critical than ever (Cresswell, Worth & Sheikh, 2010).

Complexity is, however, challenging to study. Capturing the complete picture of social reality seems to be impossible and this is important to acknowledge. On a micro-level, healthcare technology can be considered as a new element of the pre-existing network. That network can include healthcare staff and objects such as paper, medical tools and other information systems. Doing ANT driven research is also time-consuming. Although using ANT can result in surprising conclusions, there is no guarantee that this will be the case. However, ANT can also be used when making research on complex issues that cannot be understood through the use of traditional theories and methods. The main value of ANT approaches lies in a more sophisticated admiration of the active role of objects in forming social relationships in the flexible and various nature of reality, as well as theoretically informed approach to data collection and guiding sampling (Cresswell, Worth & Sheikh, 2010).

ANT can be used to discover and investigate the issues in this interconnected field of research. The theory looks into investigation of both the social and the technical, creation and maintenance of networks of both human and non-human components (Walsham, 1997). According to Tatnall et al. the main point of ANT is that:

> *"... it explores the ways the networks of relations are composed, how they emerge and how they come into being, how they are constructed and maintained, how they compete with other networks, and how they are made more durable over time."* (Tatnall, 2005, pp. 955-966).

According to ANT, the stability and social order in networks, are continuously going through the process of aligning interests. To create stability, others' interests should be translated or re-interpreted if existed before. These interests can in turn be transformed into needs, that might be further converted into more general needs, before a solution can be made. Such a translation process might include a designer who assists in "tailoring" the solution to the identified scenario (Hanseth & Monteiro, 1998). A successful network of aligned interests, and implementation of a new system, is achieved through including an adequate number of allies and translating their interests so they are eager to contribute in particular ways of thinking and behaving, which in turn maintains the network (Walsham, 1997). All needs of actors' in a network change and form a new technology. This forming of the new technology or innovation is crucial for its continued implementation, existence and survival (Hanseth & Monteiro, 1998).

ANT has been criticized for several reasons, but Walsham (1997) mentions that one major criticism is the problem of description. The amount of material becomes large, when attempting to describe all the diverse relationships between the human and non-human actors in networks (Walsham, 1997). Another ANT's weakness is being everything but a theory. The fundamental nature of this criticism is that the approach is too descriptive. It makes ANT insufficient when the intention is to give detailed recommendations of how actors should be viewed, their activities - analysed and translated (Cresswell, Worth & Sheikh, 2010). In this study I use ANT and try to go beyond the pure descriptive analyses and discuss the findings from approaches of IT development in healthcare.

Many e-health projects are small and explorative. Therefore, qualitative methods are well suited and frequently used in such studies (Andreassen & Trondsen, 2015). This study is exploiting a qualitative research method because it intends to answer the question "how do private health IT companies in Norway approach the development of hospital/clinical ehealth solutions in the context of the Norwegian healthcare sector?". It is aimed to get a detailed textual description of the work done by involved employees of the vendor-company and their reflections on the past and present in the context of software development. This sort of data is hard to capture

using numerical data. Therefore, the qualitative case study was considered feasible and well suited for the research question.

Understanding of the software development through the lens of ANT and a complexity of involved actants is the main principle that this master thesis is following. In other words, it is paying less attention to the technical part of the development, but rather on the process of how the solution was made and what can be highlighted in this process. However, understanding of the technical aspect of how the software is developed is crucial for holistic understanding of the development process and is described below.

2.3 Software development models.

It is important to understand the development models that are used in IT and how those translate in healthcare settings. This knowledge can help to understand the context of the vendor's approach towards development of IT solutions in healthcare settings and how it shapes the connection with other actors in network. One of the basic concepts of the software development — is the Software Development Life Cycle (SDLC) model. There are several SDLC models:

Waterfall model (see Figure 1) is also known as the cascade model, originally documented by Benington in 1956 and modified by Winston Royce in 1970. In waterfall SDLC development process looks like the stream, going step-wise through the stages of analysis, projecting, realization, testing, implementation, and support. Every stage includes the gradual and complete execution, is strictly documented and predefined with expected features (Munassar & Govardhan, 2010; Ruparelia, 2010).

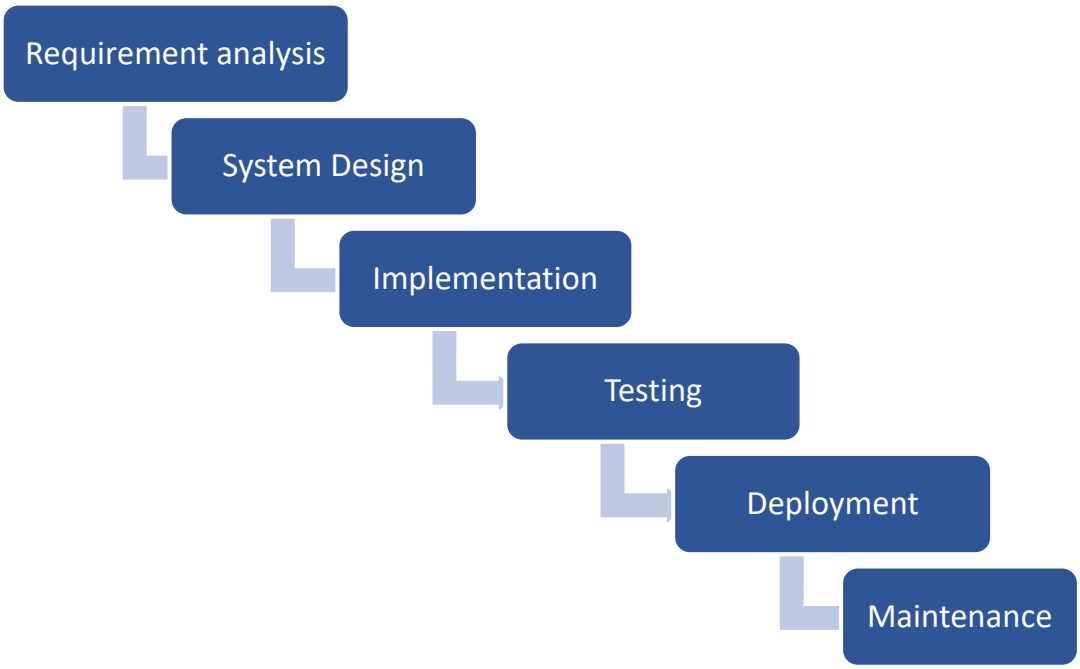

Figure 1 - Waterfall model.

Iterative SDLC model (see Figure 2) *is* combining elements of the waterfall model in an iterative circle. The Iterative SDLC model does not need the full list of requirements before the project starts. Deliverable parts of the software are produced during each iteration. The basic requirements are delivered in the first iteration, many supplementary features (some known, others unknown) remain undeliverable and are delivered at next iteration. Every iteration includes the development of a separate component of the system, therefore it is possible to develop new versions of the product for every cycle. Feedback from earlier iterations can be included in the current or future iteration (Munassar & Govardhan, 2010; Alshamrani & Bahattab, 2015).

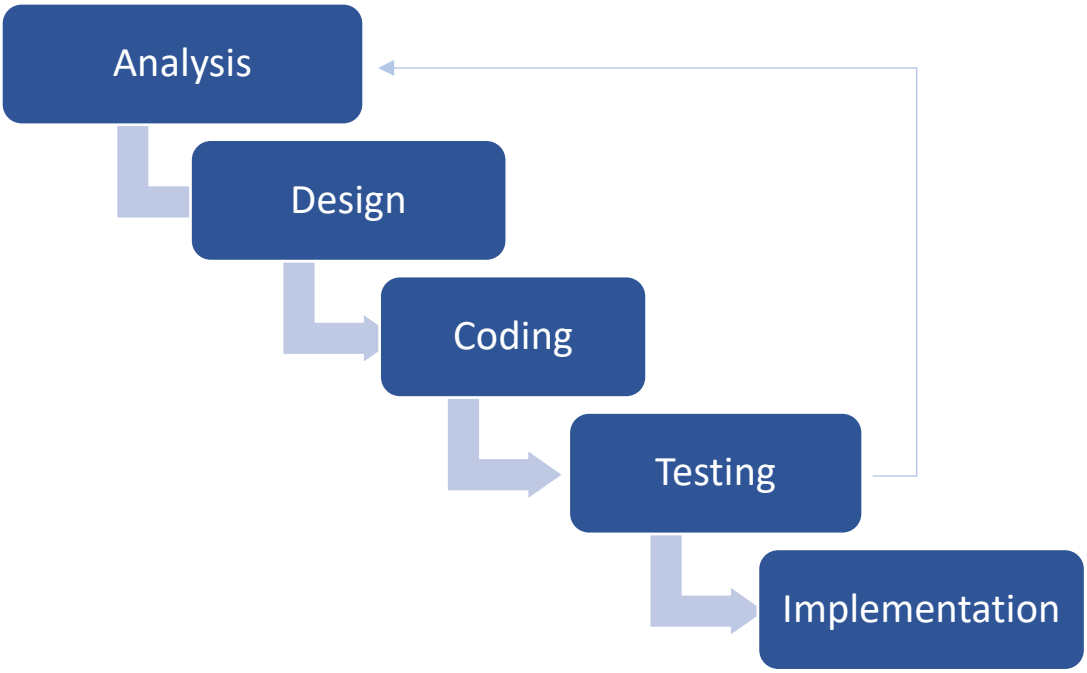

Figure 2 – Iterative model.

Spiral model (see Figure 3) – here a prototype is built, verified against its requirements and validated through testing as each cycle in the spiral evolves. The main concern of the spiral model — is identifying the correct moment to take a step into the next stage, that can be solved by using the pre-defined time-frames. The amount of time and effort to be spent for all activities during the cycle is determined in risk management (Ruparelia, 2010; Munassar & Govardhan, 2010; Alshamrani & Bahattab, 2015).

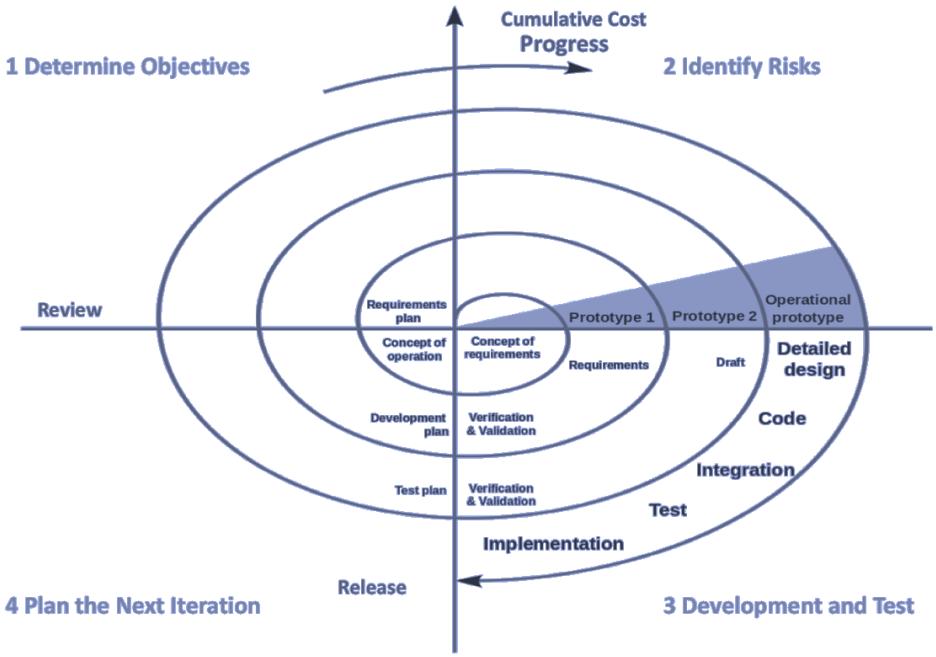

Figure 3 – Spiral model.

V-shaped SDLC model (see Figure 4) is an extension of a classic waterfall model. The next step in the model starts only after the earlier step is finished. V-model is folded and creates two legs that are symmetrical. Requirements and the design are verifiable using SMART (Specific, Measurable, Achievable, Realistic and Timebound) principle, but avoiding declarations such as "user friendly", a valid but non-verifiable requirement (Ruparelia, 2010).

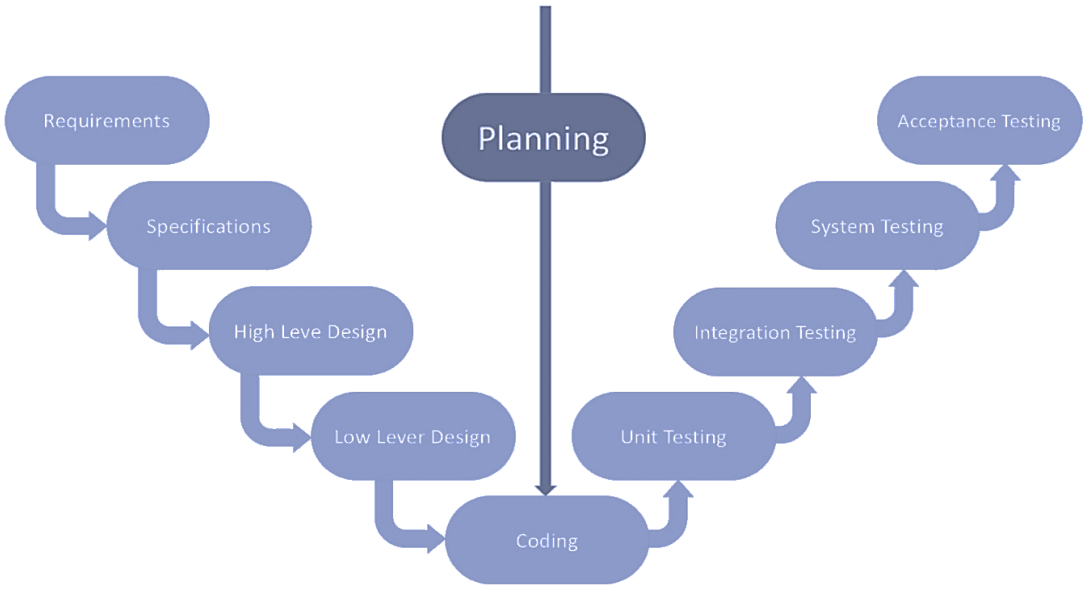

Figure 4 – V-model.

In the *Agile methodology* (see Figure 5) after every development iteration, it is possible see the result, so a customer can see if the result is satisfactory or not. Agile methods put emphasis on teams, customer collaboration, responding to change and working software. The basis of such a model consists of short periods, so called "sprints", that are included in a scrum approach. Since the 'up-front' requirement gathering as stakeholders is not available in sufficient details, those sprints are necessary (Leau et al., 2012).

-

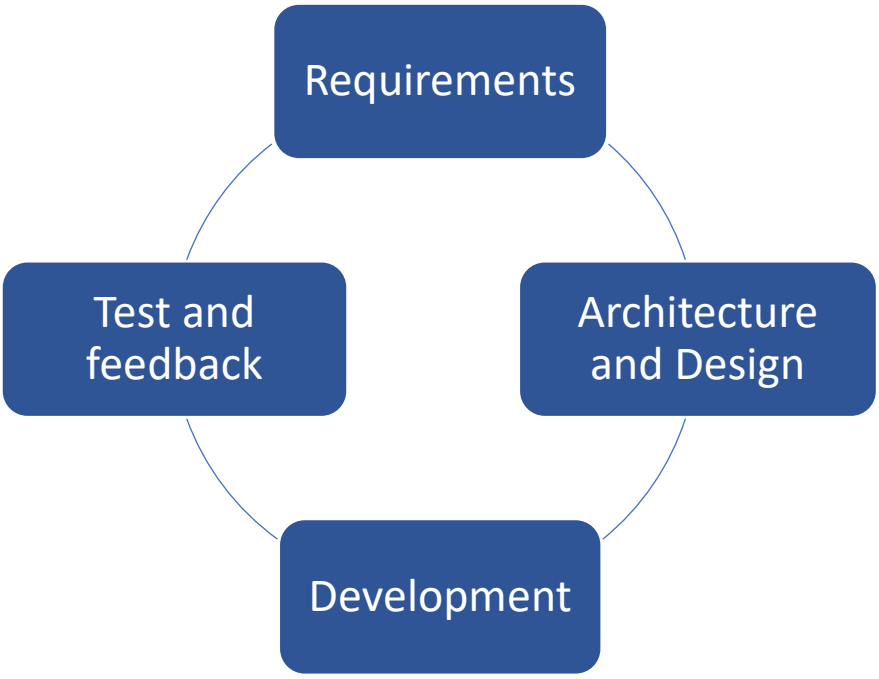

Figure 5 – Agile model.

2.4 Software development in healthcare.

Software product development for healthcare takes place primarily in vendor-companies also called health information technology providers (Martikainen, Korpela, Tiihonen, 2014). Those vendors differ in size and the market being served.

Software development within the health domain is different from other domains for several reasons. Healthcare is a fragmented industry with, for example, independent hospitals, medical device companies with different stakeholders. So, introducing a new solution can require change management, a specific approach to transition an organisation to a desired future state (Carroll, Richardson, Travers, 2017).

Visions from social sciences are becoming more and more accepted within the field of health informatics and information systems in general. There significant importance of ehealth technologies and their potential for improving health can't be foreseen anymore. The development of ehealth technologies should include not only technology, but also consider the social dynamics and go beyond pure technological development. Development of a new technology often requires clarification of the processes and elements around the healthcare delivery, for example how payment is organized, identification of key stakeholders. It also demonstrates the interrelations between socio-cultural environment, people and technology, infrastructural organization of health care (van Gemert-Pijnen et al., 2011).

Socio-technical approach and design principles are used within healthcare IT development too. Technological innovation can be viewed as a social process in which organisations are deeply affected (Berg et al., 2003). Socio-technical approaches focus on the nature of health care work and working with information technologies as a social process. A socio-technical design approach can therefore hold a huge value when designing a new IT system in healthcare, as the nature of healthcare work is naturally irregular and "ad hoc" (IAMOT 2018 Conference Proceedings, 2018).

An increasing number of studies have underlined the importance of a participatory development process involving users and other stakeholders such as decision-makers, payers, insurers and government officials in order to hit an important aim - increase the uptake of ehealth technologies (van Gemert-Pijnen et al., 2011). Some researchers consider users as an inseparable element of the network in software development process. However, in traditional IT design methodology very often design decisions are made by the IT designers and/or developers, while user participation is limited. Requirements Collection have been especially challenging in traditional systems analysis and design methodologies. Users, potentially, can be an important sources of design information. Users' perspective and contribution is considered to assist and help with design process to ensure technology to be usable, useful and attractive for consumers. One of major problems of the requirements gathering process is considered to be a lack of common understanding of and communications with end user groups (LeRouge et al., 2013). Yet the role of stakeholders is not often addressed, nor is the potential of ehealth technologies to develop infrastructures for more cost- and outcome-efficient, easier-to-get health care services (van Gemert-Pijnen et al., 2011). One possible way to "step into the shoes" of users and stakeholders is to use Design Thinking.

Design Thinking is built on a similar approach as the agile methodology, having an iterative nature and improving the outcome over time with more iterations passed. It is an approach where development of empathy for users, using "action-oriented rapid prototyping" of solutions and working in co-operative multidisciplinary teams is highly prioritized. As mentioned, it is an iterative process and several rounds of ideation, prototyping, and testing are required for innovation to emerge. Traditional linear and top-down tactic to health intervention design is significantly different from Design Thinking. Instead, Design Thinking is more similar to both "user-centered design" (UCD) and "human-centered design" (HCD) (Altman, Huang & Breland, 2018).

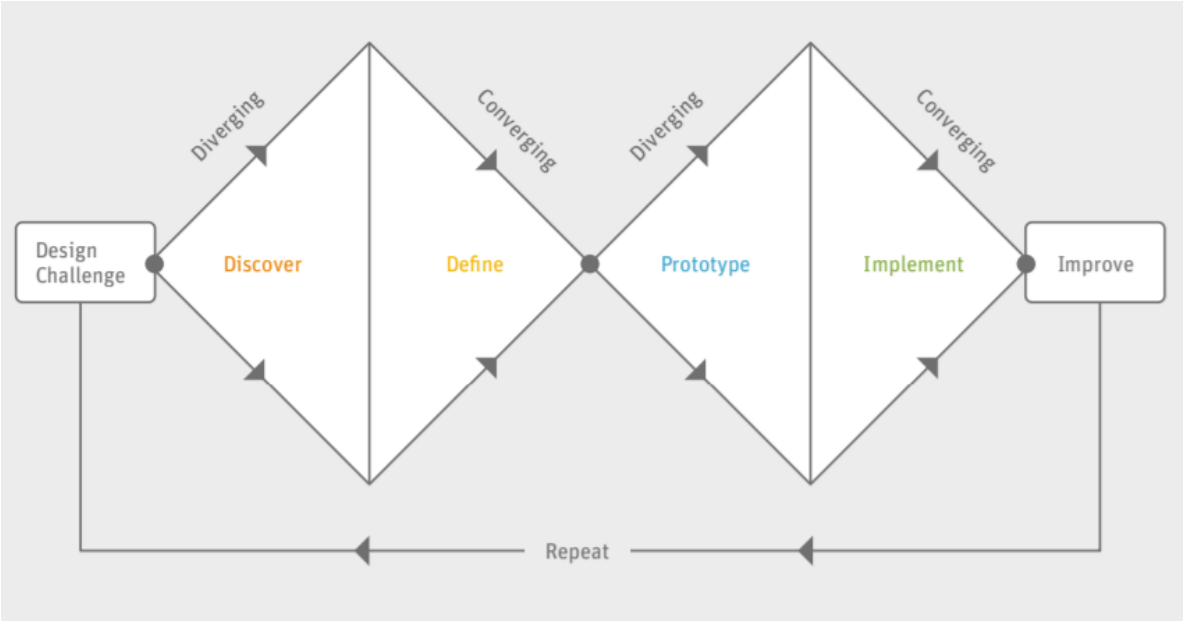

Figure 6 - The human-centered design approach. (source of figure (Liebenberg, 2020))

While the HCD process has many forms, the proposed model suggests five key steps: Discover, Define, Prototype, Implement and Iterate (see Figure 6) and in this way reminds of Design Thinking. Discover' is about thoroughly exploring and defining the problem, building empathy, and gaining a deep understanding of the users and their current context – meeting them in their reality. 'Define' is a process of synthesis and interpretation. This phase involves translating findings from the Discover phase into insights that inform the design problem and identify opportunities that guide the ideation process. The Define phase is the stage at which collaboration from all stakeholders is most beneficial to generate ideas and identify possible solutions for the problem that is to be addressed. These solutions are made tangible through the Prototype phase, during which a series of low- to high-fidelity prototypes are tested with users. The Prototype phase is also iterated to create a refined solution that can be brought to life in the Implementation phase. The nest and last phase, which is crucial, but often omitted, is the Improve phase. The Improve phase is all about agile development and consistent iteration. The service is optimized based on real user data – the experience is refined through analysing what works for users. This phase involves smaller cycles of the design process to refine and add elements to the intervention. (Liebenberg, 2020)

3 Method

3.1 Design and approach

3.1.1 Research design

Researcher in e-health is offered multiple scientific research designs and various data production and processing methods due to the multidisciplinary nature of the e-health research field. The choice of method should be based on the questions that the researcher wants to address (Andreassen & Trondsen, 2015).

Different frameworks, methodologies and guidelines are being developed for both technical and non-technical aspects of the software development process. How the solutions are made is, therefore seen as an important part of understanding how those solutions are being implemented, used and utilized by healthcare professionals. Selecting the right methodology is crucial, as the type of method selected impacts the conclusions that can be drawn from the research. The proposed research questions and objectives were the basis to form the research strategy and choice of the case, as well as choosing qualitative method a data collection approach.

3.1.2 Qualitative research

Qualitative research is used to find, describe, explore and understand the underlying background, context and features of any phenomenon (Cypress, 2015). It helps to get what, how and why of the social phenomenon (Stoop & Berg, 2003). This deeper understanding of its specific context can be achieved only through a qualitative inquiry rather than using quantitative research (Cypress, 2015). Qualitative research methods include the consistent collection, organization and interpretation of textual data, obtained from interviews and documented. The findings from qualitative studies are expected to be generalizable. The latter means that those can be used when studying other populations, causal relationship as well as cause-outcome connection, modelling predictions (Leung, 2015).

Qualitative research has a fundamentally different set of features compared to those in quantitative research. Qualitative research generally draws on post-positivist or constructivist beliefs. According to positivist paradigms, there is only one reality that can be discovered with suitable experimental methods. Post-positivist paradigms agree with positivist ones, but also believe that individual and environmental differences, such as the learning culture or the

learners' capacity to learn, are important and affect this reality. In contrast, according to constructivism, there is no sole reality. Instead, a researcher produces participants' reality views (Teherani, Martimianakis, Stenfors-Hayes, Wadhwa & Varpio, 2015).

Qualitative research is an adaptive research design that evolves throughout data collection as all aspects of it are being revisited (Robson, 2002). Qualitative research is best suited to understand a phenomenon as experienced by individuals themselves, in their natural context. This type of research is capable of searching for answers starting with „what", „why", and „how", aimed to pick out hidden details of a social phenomenon (Kaplan & Maxwell, 1994). How individuals and groups behave, how interactions shape relationships, how people experience aspects of their lives, how organizations operate are only a fraction of what qualitative research is used for (Teherani, Martimianakis, Stenfors-Hayes, Wadhwa & Varpio, 2015).

The main methods for collecting qualitative data are individual interviews, focus group, observations, action research (Le.ac, n.d.). The researcher is the central data collection instrument in qualitative research (Teherani, Martimianakis, Stenfors-Hayes, Wadhwa & Varpio, 2015). The less formal relationship between the researcher and the participant is a natural part of qualitative research. Participants have the chance to respond more elaborately and in greater detail than is normally the case with quantitative methods. Researchers also can respond immediately to what participants say by adapting the following questions as a reflection to information provided by the participant. In this way, participants are free to respond in their own words, and these responses tend to go beyond simple "yes" or "no." Qualitative methods allow greater freedom and modification of the interaction between the study participant and a researcher (Mack, 2005). Therefore, the qualitative approach was considered appropriate.

3.1.3 Exploratory case study

To develop new knowledge on how do private health IT companies in Norway approach the development of hospital/clinical ehealth solutions in the context of the Norwegian healthcare sector I use a explorative case study approach. C. Robson defines a case study as a strategy which involves an empirical investigation of a phenomenon within its context using several evidence sources. (Robson, 2002)

Case studies are broadly used to gain insights that might not be achieved with other approaches. Case studies have often been regarded as a useful tool for the initial, exploratory stage of a

research project. Data is examined at the micro-level when a big sample is problematic to obtain. A case study is an ideal methodology to bring out the details from the participants' viewpoint. Case studies present data of real-life situations, and they provide better insights into the detailed behaviours of the subjects of interest. Through case study methods, a researcher is able to go beyond the quantitative statistical results and understand the behavioural conditions through the actor's perspective (Zainal, 2007).

For projects with problem that is not very well understood and projects focusing on a subject with high levels of uncertainty, exploratory research is the most suitable and proper research design (Van Wyk, 2012). Since exploratory case studies are by definition often applied in a research context that is not clearly specified and still requires data for the formulation of valid hypotheses, their broad concept provides the researcher with a high degree of flexibility and independence with regard to the research design as well as the data collection, as long as these fulfil the required scientific criteria of validity and reliability. An exploratory case study is, therefore, not limited in terms of its qualitative or quantitative specificity (Mills, Durepos & Wieb, 2010).

When it comes to implementing digital technology in hospitals, the region of North Norway and the Regional Hospital of Tromsø (RiTø) (now – University hospital North Norway (UNN)), are standing out. The hospital was among the very first hospitals in Europe that offered health IT services. Digital X-ray images were adopted following both the initiative of X-ray healthcare professionals in Tromsø and being inspired by Televerket's early investment in telemedicine (Hurlen, 2012, Helse Nord, 2014; Hartvigsen et al., 2007). The solution was later commercialized and was among the first of several successful launches from the Tromsø environment. This is one of the reasons why this study is focusing on the development of the solution.

The research site, a Norwegian vendor-company, is a provider of services and solutions including software for RIS (radiology information system), PACS (picture archiving and communication system), teleradiology and sending documents and files with sensitive patient information.

An explorative qualitative case study approach has been considered as suitable for this case study, on which interviews and document analyses have been the main method of data collection. This research is based on interviews and analyses of relevant documents. Case

studies have a selective nature, focusing on one or two issues. Those issues are essential for understanding the examined system (Tellis, 1997). Therefore, the initial research question got a much more focused direction while conducting this study. This will be discussed in this chapter later on.

However, inability to generalize the results, lack of rigour and the tendency for a researcher to have a biased interpretation of the data, is a disadvantage of a case study and should be addressed in by a researcher when relevant.

3.2 Data collection

As a method, ANT allows using several data sources as a way to strengthen a case (Sköldberg, 2009; Hansen, 2011). Beginning from the chosen actant, the research then starts by exploring and "unwinding" this actant with the related human and non-human actants. In this exploration, it is important to 'hear' the actants involved. This is usually done through observations, interviews and the analysis of documents (Dankert, 2011; Farquhar, 2008).

3.2.1 Gaining access

One of the greatest disadvantages of conducting a research successfully is the inability to obtain access to the research field. Researchers often use a large amount of time on this task, especially when the research an in-depth study is required (Johl & Renganathan, 2010). This task can be even more challenging if the research topic is sensitive. For example, access to a medical setting may be hard to obtain in the context of strong gatekeeping, such as when researching vulnerable patient groups or when health professionals and administrators regulate study recruitment. Another challenge relates to reconciling rigid research ethics committee guidelines with the flexible nature of qualitative research (Høyland, Hollund & Olsen, 2015).

These obstacles to overcome often include demanding negotiations not only to gain initial access but also to maintain such access throughout the data collection process. A crucial component of successful access is represented by gatekeepers, or individuals who can help or hinder research depending on how they view its validity and value (Høyland, Hollund & Olsen, 2015).

Access to e-health vendors might be even more challenging, as there are few ehealth vendors, and one vendor can serve a number of healthcare institutions with its solutions. As the

competition is high in the technological industry, with more startups coming to the market, the access to research an e-health vendor can become even more complicated.

The researcher met one of the key informants before the research started through a mentorship program for students at the University of Tromsø. During the research process, a second key informant was identified, representing the health professionals side. This key informant became a second touchpoint between a researcher and potentially relevant participants. Both work or have worked for the vendor. Both key informants were asked to suggest who else the researcher should contact. Later, both key informants became informant 1 and informant 2 interviewing process, respectively.

As mentioned above, the access to key knformant 1 from vendor company was considered as a unique opportunity to gather an in-depth understanding of development processes in a private healthcare health IT vendor-company and connect it to the master thesis done at the University of Tromsø. The collaboration on the master thesis was discussed and officially agreed in May 2018.

3.2.2 Participants and recruitment process

Representative sampling reflects the population being studied. Theoretical sampling is a common strategy in qualitative research and the approach in this research. Aim of such sampling is to recruit informants that will give the most and best information on specific study questions. Snowball approach is widely used when appraising a new empirical field, and you don't know the number of informants or who will provide the relevant information (Andreassen & Trondsen, 2015). For that purpose, a snowballing approach usually starts with a few key informants.

Both key informants were essential to the whole recruitment process. The additional informants were suggested and picked based on having an active employment status, having a prior employment history in the company, being involved in the development of the product(s) no matter the background and the role in the company hierarchy. This became the inclusion criteria for the interviews. This was used as primary recruitment and sampling strategy.

The labour-intensive nature of data collection and analysis is the primary reason for small samples in a qualitative research approach (Popay & Williams, 1998). There is no defined answer to what number of participants is enough. In order to gather in-depth information on the

development process, you may want to interview representatives from various groups of actors (Andreassen & Trondsen, 2015). The aim of this study is to gather in-depth knowledge on the design processes in a specific vendor-company and therefore focus on the group of stakeholders that are especially relevant to the case. As in all research, the researcher and author of this thesis have the responsibility to ensure the research of high ethical quality.

The actual recruitment process, contacting the informants and asking for participation in the research project, was mainly done through e-mail and telephone calls. Prior to setting up the interviews, the potential informants were provided with necessary information about the researcher, got a fundamental awareness of the reason why they are being contacted. Interviews were then planned individually through mail and phone contacts directly with the researcher and were provided and afterwards giving consent for data collection and analyses. The sampling continued up to the point of analytic saturation when no new themes are emerging.

3.2.3 Document analyses.

The Key Informant 1 was a member of the vendor's Board of Directors, where researcher have also participated. This gave a unique opportunity to gain insight knowledge of the strategy work done in the company based on the current situation, retrospective on decisions made as well as planning for the future. Participance in the meetings of Board was a good way to get to know the company and some of the future participants in the research. Access to the documents from meetings of Board of Directors was a background for interest to start this research project. Those documents were analysed but, however, were not used in this research. Document analysis was rather an inspiration and background for the growing interest in research topic and this is worth mentioning.

3.2.4 Interviews

The use of interviews in qualitative research does not have a significantly long history. Qualitative interviews have their roots in "the anthropology and sociology of the early decades of the twentieth century" (deMarrais & Lapan, 2003).

From a scholarly point of view, Sewell (n.d) defines interviews in qualitative research as "attempts to understand the world from the subject's point of view, to unfold the meaning of peoples' experiences, to uncover their lived world before scientific explanations" (Sewell, n.d.).

Interviewing suits well to capture the individual differences and complexity and therefore, is widely used in e-health research (Andreassen & Trondsen, 2015). There are three types of interviews: structured, semi-structured and unstructured. The semi-structured interviews are formal interviews commonly used in healthcare-related qualitative research and will also be used for this research (Al-Busaidi, 2008). The researcher sets the outline for the topics covered in a semi-structured interview. But the interviewee's responses determine the development of the interview process (Stuckey, 2013).

Semi-structured interviews are used in this study to determine not only 'what happened' but also participants' explanations of 'why it happened' in that way. This type of interviews has great flexibility. Semi-structured interviews are often constructed with "open-ended" questions may not be worded in the same manner with each interviewee. The loose structure of open-ended questions is designed to explore attitudes, perspectives, understandings, experiences and meanings constructed by people regarding the events. Questions in this type of interviews can be changed based on up-and-coming themes throughout the process. This agility in the communication between informant creates a "soil" for in-depth stories. Participants can respond with natural words, rather than pushing them to choose from fixed responses, that is widely used in quantitative methods. The researcher must carefully follow what participants are expressing, reflect individual personalities and styles while motivating to encourage participant to elaborate on their answers further. This richness and detailed nature of interviews have a downside. A researcher should be aware that the semi-structured interview type of interviewing may take a longer time to conduct and analyze, as well as reduce the researcher's control over the interview situation (Al-Busaidi, 2008).

Questions were prepared beforehand in order to obtain a more in-depth understanding of the interviewees' views and opinions on particular issues and to keep some standardization between the conducted interviews. A certain amount of flexibility was, however, considered as necessary due to the different roles of the participants.

Interviewees in this research study are asked for a description of the way the company and employees develop their e-health solutions from their perspective, their views about the product development from the very beginning of the company till now, and simply the story behind the way was done. Interviews are recorded into a digital audio-file and transcribed verbatim, with the interviewer keeping additional field notes.

Most of the participants were aware of the researcher and have been introduced via the key-informants in person or electronic means. Participants were informed of the interviews' topic in advance as participants were provided with thorough information about both the study and interview process orally and in a written form (email). This was done in order to minimize the chance that the answers given during the interview were produced under pressure. The time gap between the invitation to the interview and interview itself gives time to reflect on the topic and be, in a way, mentally prepared to answer the questions. The location of the interview has to suit the individual interviewees and be a familiar environment, that is a way to make the interviewee comfortable (Andreassen & Trondsen, 2015). The interviews, therefore, were conducted at participants' workplace or place of choice. The interviews were either done through Skype or FaceTime, depending on preferences of the participant. The length of the interviews was set around 30-45 minutes, but in reality, it was closer to 60 minutes each.

In this study, the vendors' approach and work to develop ehealth solution is not seen as a purely technological process, but rather as a combination of socio-technical factors that influence the process as a whole. The interviewees were asked to reflect on such technical and non-technical artefacts as a history of the ideation behind the solution, history of the company itself, the team members and their background and competence, financing and commercialization process, political environment, collaboration opportunities, technological background, location of the company and customers, nature of the solution and the changes coming with its creation and implementation, user-involvement in the development process, etc. All abovementioned factors are important to investigate in order to gain a holistic understanding of the development process.

Seven interviews were conducted through employees who have worked or still work at the vendor-company and have been a part of meetings with members of the Board of Members. Other sources of data such as news articles, relevant literature, reports and White Papers were also used. "Everything is potential data" - is the most important principle of qualitative data collection (Kaplan & Maxwell, 2005). The quality of interview-gathered data is ensured with a sufficient length of the interview itself.

Before the interviews were conducted, a description of the study was sent for approval from the Norwegian Social Science Data Service. Participants were informed that participation is voluntary and can be stopped at any time without giving any reason. Informed consent was retrieved in cases where participants were interviewed.

3.2.5 Data Analyses

All actors in a network translate and shape a new technology according to their own needs. Therefore, it was important to identify the actors in a network. Following the ANT, explicit and potential factors that could influence the vendors' approach to development of ehealth solutions were identified. Living and non-living actants were taken into consideration based on the data analyses done on the obtained data.

According to Kaplan & Maxwell, there are four basic techniques of qualitative data analysis: coding, analytical memos, displays, and contextual and narrative analysis. Coding in qualitative data analyses involves selecting particular segments of data and sorting these into categories (Kaplan & Maxwell, 2005). Coding is done using a word or short phrase that symbolically assigns a summary, essence and attribute for a portion of textual or visual data (Saldaña, 2016). Anything that a researcher writes in relation to the research, other than direct field notes or transcription are defined as an analytical memo. It can be a comment on a transcript, or a theoretical idea in field notes or even an essay, facilitating reflection and analytical insight. Displays, such as matrices, flowcharts are used for data reduction and the presentation of data or analysis (Kaplan & Maxwell, 2005). They represent ways of organizing, simplifying, summarizing or transforming data (Verdinelli & Scagnoli, 2013). Contextual and narrative analysis, as an alternative to coding, uses discourse analysis, narrative analysis, conversation analysis, profiles or ethnographic microanalysis. Those techniques seek to understand the relationships between elements in a particular text, situation, or sequence of events (Kaplan & Maxwell, 2005).

All the techniques mentioned above are done to index themes and categories that are checked or compared with the rest of the data to establish analytical categories. Once the analytical categories are created, they are further refined and reduced in number by grouping. Key themes or categories are selected for further investigation (Pope, Ziebland, Mays, 2000).

The data obtained from interviews was carefully transcribed, analysed and categorized and thematic coded manually. However, the same procedures can be conducted using a computer and software. This may be a useful aid when gathering, organising, and reorganising data and helping to find exceptions, but not for "analyzing" the data in the sense that statistical software does (Kaplan & Maxwell, 2005).

The empirical foundation is based on open-ended interviews with employees from the vendor side who directly or indirectly take part in the development of the solutions provided by the company to the market. The list of potential informants included both current employees and former employees of the company.

3.3 Reflections on the method

3.3.1 Researcher role and quality

When conducting qualitative research, the researchers have an active role in the process, and his background and position will affect the study in multiple ways (Malterud, 2001; Walsham, 1995). The angle of investigation, the findings, the framing and the communication of the conclusion will all be affected by the researcher's knowledge and prejudices, and therefore influence the way it is interpreted and communicated to the reader (Walsham, 2006). This is closely related to aspects of validity and requires a systematic assessment of the effect the researcher has on different steps of the study.

Validity represents how precise, clear and accurate the findings reflect the obtained data (Noble & Smith, 2015). Researcher's bias is a potential challenge in achieving high validity in qualitative research. It comes from selective collection and recording of data, or interpretation based on personal perspectives. Interviews, being a common method of data collection in qualitative research, need to be checked for validity (Roberts & Priest, 2006). Concepts as rigour, quality and trustworthiness can be used as alternatives to validity. Those were either created or adopted by different researchers and claimed to be more suitable terms for scientific research (Golafshani, 2003; Bashir, Afzal & Azeem, 2008). According to Roberts et al. enhancement of validity in qualitative research can be done with triangulation, that combines two or more theories, data sources, methods or researchers in the study of a topic. Using triangulation increases the consistency, comprehensiveness and robustness of the study. Checking with documentary evidence and published literature, cross-case analysis and comparisons across data from different groups of participants are examples of triangulation (Roberts & Priest, 2006). The researcher is offering an interpretation of reality.

Non-availability of generalizability option is considered as a negative side of doing a qualitative research. The goal of qualitative research is to understand the particular in-depth, rather than trying to find out what can be generalized to a bigger population. If the assumption is made at the beginning of the study that the findings are descriptive in nature, representing one life

perspective, as in some life histories, for example, the applicability criterion may not be relevant. In such a case, data are of descriptive worth in and of themselves (Merriam, 1995).

Although the term 'reliability' is now more often used in all kinds of research, not only in quantitative research (Golafshani, 2003). Reliability is the consistency of the analytical procedures that take into account biases for personal and research method that may have influenced the findings (Noble & Smith, 2015). Findings should be confirmed by revisiting data in different circumstances. Interview data, for example, may be sent to an independent researcher to verify how much agreement there is about findings and analysis – a form of inter-rater reliability (Roberts & Priest, 2006). Confirmability is the degree to which the outcomes could be confirmed by other people. It does not necessarily mean that another person would reach exactly the same conclusions as the researcher did. What is important here is to clearly show where interpretations come from. In addition to that, demonstrating parallel meanings across the data set can also generate confirmability. So, rather than choosing to support conclusions from one aspect of the data, it is better to show that interpretations are applicable across multiple aspects. Tape-recorded interviews and interview transcripts can also help to improve reliability. However, non-verbal aspects of communication are sometimes omitted from transcripts if a record contains only voice (Roberts & Priest, 2006).

According to Malterud, these steps should be shared in the publication, and serve as a frame for the discussion of limitations and strengths, as well as the transferability of findings. Although this does not eliminate bias, it will indeed account for it (Malterud, 2001). As Walsham argues that our knowledge of reality is based on an understanding of social constructions, the question is not whether the researcher affects the process, nor if such effects can be eliminated (Walsham, 2006). The researchers' effects can, however, be countered by applying an agenda of objectivity to the process (Malterud, 2001). In relation to qualitative research, this means to recognize that our knowledge is partial and context-dependent, therefore the researcher's role and the position within the social construct of the research site should be highlighted when applicable.

As I was in contact with a research site before the research started, I strived to assume a neutral role, in a manner that countered the opinion that I could have from the past. According to Klein and Myers principle the data is socially constructed through the interaction between the interview participants and ourselves (Myers, 2011). The measures that helped me to stay neutral

were – ask as much as possible open questions during the interview, use snowball sampling and be open about any additional story to be told by participants.

4 Findings

To understand how a private health IT company in Norway approached the development of hospital/clinical ehealth solution, I started by interviewing study participants, analysing the data and mapping the main actors in the field. During this mapping process it soon became evident that there are several living and non-living actants. This was an expected outcome, as ANT considers an active role of objects in shaping social relationships in the fluid and multiple nature of reality. It investigates the creation and maintenance of networks of both human and non-human elements where the social and the technical are indivisible and co-dependent (Cresswell, Worth & Sheikh, 2010; Walsham, 1997). The mapped actants, that are composing the whole complex picture of healthcare development approach, are presented below.

4.1 Region hospital

Northern Norway has a unique context and history when it comes to ehealth and telemedicine (Walderhaug, Granja, Horsch & Hartvigsen, 2015). The Northern Norway Region, and Tromsø particularly, was among the first places in Norway where telemedicine was established and used (Sosial- og helsedepartementet, 2020). Inhabitants living in rural and remote areas in the Arctic region have been using telemedicine and ehealth services for years, so the region is widely known for early implementation of such services there. The possibilities to offer high quality healthcare to everybody, irrespective of where they live, were obvious. So the development of telemedicine services in Northern Norway have been recognized and initiated by visionary politicians, health administrators, healthcare professionals and researchers (Walderhaug, Granja, Horsch & Hartvigsen, 2015).

Back in 1975, Regional Hospital of Tromsø (RiTø) (now - UNN) became a regional hospital, including regions Norland, Troms, Finnmark and Svalbard. According to one of the informants, the regional status brought “challenges that have something to do with distance”. The regional hospital started to serve patients who were not only living in Tromsø and in city surroundings, one of these services was radiology. The fact that radiology was chosen may not be a coincidence, as radiology may be split up into two different areas: interventional radiology and diagnostic radiology. The latter includes computed tomography, magnetic resonance imaging and magnetic resonance angiography, mammography, x-rays, in other words imaging, that could be done, stored and transferred digitally (Medlineplus, 2020).

Information and communication technologies help to overcome distance, so those became a foundation for ehealth and related concepts (Otto et al., 2018). Therefore the creating and introducing ehealth or telemedicine solution was a logical answer to the problem that radiologists were facing. As mentioned above, RiTø was a pioneer in the field of e-health, having radiologists who started to use and transfer digital images and saw the potential of digitalised service early on. As key informant 1 shared, the Radiology Department became linked to all hospitals in the Northern Norway Health Care Region for teleradiological consultations.

When it comes to implementing digital technology in hospitals, the region of North Norway and the RitØ where the vendor first was established, are standing out. RiTø was among the very first hospitals in Europe to offer the North Norwegian population health IT services. The Radiology Department at RiTø was able to transfer X-ray pictures from the hospitals in Nordaland, Troms, Finnmark and Svalbard to the main radiology department of the hospital, located in Tromsø. The developed teleradiology system was the world's first large-scale solution with image transmission and requisition / response logistics in continuous operation. The solution was later commercialized and was among the first of several successful launches from the Tromsø (Hartvigsen, 2016).

Overall, the "pieces of puzzle came together" when RiTø became a regional hospital in the area where the need for ehealth services was and still is high. Those two factors happen to be a prerequisite for ehealth solution being developed, reflecting the needs to overcome challenges. And the fact that the solution's development took place initially inside the hospital itself, could be one of natural outcomes of the established context.

4.2 Workflows.

As shared by informant 1, prior to digitalization, Healthcare professionals from the Radiology Department travelled long distances to other hospitals and helped colleagues to interpret the pictures and describe them.

> *"A doctor in Tromsø was waiting to serve other hospitals during that period, so it was an obvious need to create a digital project between RiTø and one of these hospitals that we cooperated with. There was a so-called Tromsø military hospital which was a combination of military and public hospital in the inner Troms, which is 2 hours' drive from Tromsø. And we drove up with a car once a week, read and described all the pictures from the production of the whole week. We used the whole day: started early in the*

morning, ran up, did the diagnostic work, got papers and could come home around 5-6 pm. It was nice during summer, but worse in winter due to bad weather conditions."

This is how this process looked like (see Figure 7).

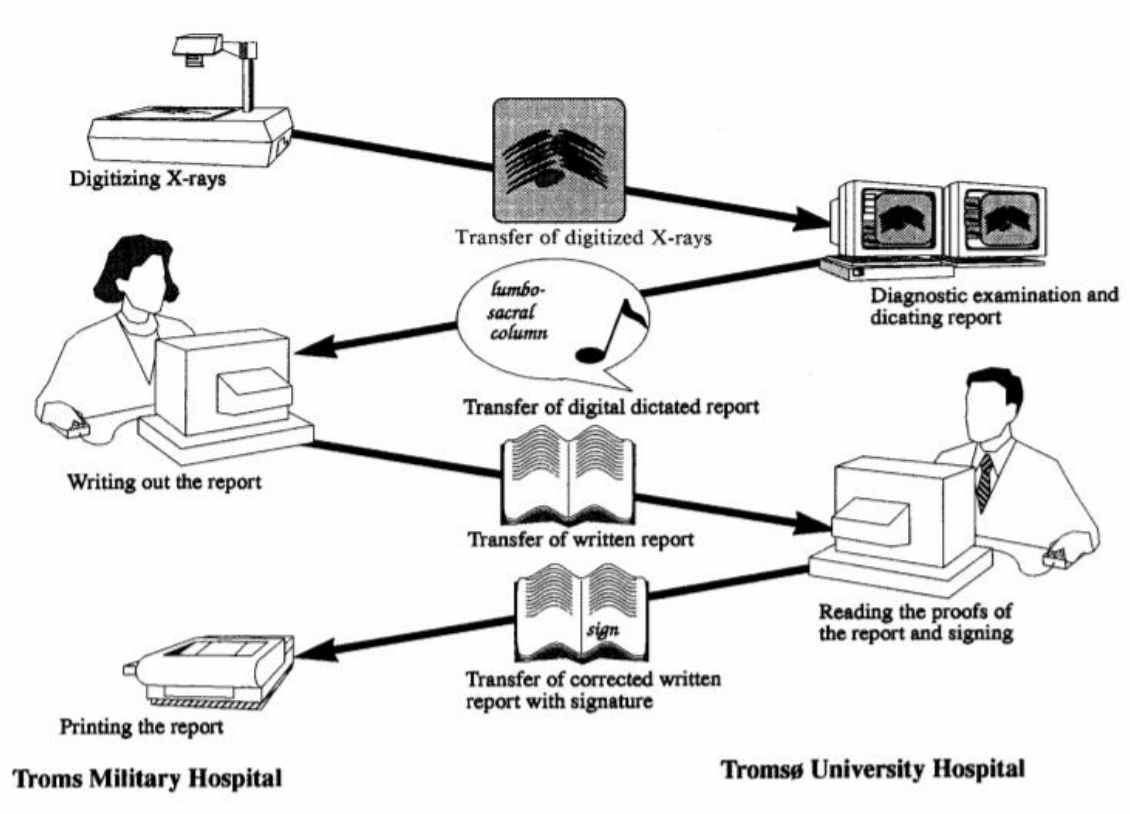

Figure 7 - Radiology workflow in Tromsø University Hospital *(Source of illustration* (*Rinde, Nordrum, Nymo,1993))*

Already in 1995 the service became all-digital. The teleradiology service developed at RiTø was used by Troms Military Hospital more than any other hospital in the region (Hartvigsen et al., 2007).

As key informant 2 shared:

"Very many patients who were sent to UNN had serious illnesses and had X-ray examinations at all local hospitals before they came to Tromsø.".

Challenging logistical and workflow issues around picture sharing, description and diagnostics showed the need to have a system to overcome large distances and digitalise the service. As expressed by informant 1:

"If a doctor in Tromsø knew about a patient in Mosjøen, then you should have personally called the doctor (author note: in Mosjøen), *who would send the pictures 1-*

1 to the doctor in Tromsø. Then the doctor in Tromsø, if he thought it was useful, went to the Radiology Department and met a random doctor and asked what he thought about the received pictures. This system was relatively unrealistic and dangerous."

A new system in developed should fit organizational purpose, clinical practice as well as the regional aspects with several institutions and long distances between the institutions. There are many examples of systems that have been obtained but never used or are installed in unintended ways. Such systems can be perceived to undermine professional values, that will then consequently not succeed, with less improvements than expected (Cresswell, Bates & Sheikh, 2013). Having a good understanding of the workflow, therefore, is crucial.

Creating a new highly integrated system with a pre-existing "installed base" requires the designers to have relatively detailed knowledge about the existing systems, interfaces and work practices, that form an "installed base". Moreover, the designers must take into account interdependencies between the systems, information flow, various technologies, accountabilities, interests and layouts (Johannessen & Ellingsen, 2009).

The implementation of the very first version and iterative development of the new functionality and updates could not be done without drastically changing the workflow. This is what both healthcare professionals and the company employees had to work with and agree on.

As informant 5 shared:

"We have made changes to the workflow that were not so well received right away, as we somehow had a bigger perspective on it. So of course there have been some such processes that have been a bit difficult .. but it has gone really well. It was good to be close to the user and be able to explain why you have done things. Then, in a way, they have been able to accept this small development period until the new version was in place."

The change management was, however, not always an easy process. Some obstacles with proving the value to the users while implementing the solution in other hospitals in the region, that were the part of the digitization initiative at RiTø.

"And we have also been very early on introducing digital solutions for … and for external in hospitals. So we have to somehow force them to use electronic solutions that have often been more complicated for them in the first place. It has been easier for them to just write (gunpowder) on paper and send (---). But we have forced them to use electronic solutions.

Then, in a way, they have not seen the value before they have eventually been able to do searches and lookups in electronic data that they have (filled) themselves entered. So.. of course it was a fight. There was also a hospital in Tromsø that had the policy that nothing, it is not accepted paper, does not make it so not allowed to submit text, finished talking. So very good then ..." – as shared by informant 1.

There are two general workflows that are mentioned in literature. The first is the pre-established workflow, defined as the workflow in an organization as a whole or at a specific level prior to the ehealth intervention. The second is the new workflow, describing the workflow after the ehealth intervention is in place. Some researchers argue that in order to succeed, ehealth interventions should fit and adapt to the workflow that is already in place. Others support that in order for the ehealth intervention to be successful, the workflow is required to or will be changed. Those changes affect not only directly involved staff, but also others within the organization. Therefore, changes in the workflow can have both a negative and positive way impact on the organization (Granja, Janssen & Johansen, 2018).

It is far to conclude that workflows in healthcare are very complex. Therefore, developing IT solutions to support or change workflows is challenging, as the effect of the implementation of technologies on healthcare is significant. Workflow adjustment comes with the risk of introducing unforeseen errors in the healthcare delivery (Lluch, 2011; Coiera, 2009). There was a clear need to change workflows due to introduction of a new technology, so understanding how to go from old workflow to the new one was crucial.

4.3 High motivation and competence.

As expressed by all informants in this study, there was a great need and motivation to get a digital solution in place that could help both healthcare professionals and patients, making the logistics around x-ray pictures more efficient. As shared by informant 1:

"We had a great motivation to put in place a digital solution that allowed us to get pictures taken up there [at the local hospital] faster to Tromsø, and we could see in Tromsø, describe them, establish the report .. but part of the challenge was that the report should be written there at Tromsø military hospital. And at the same time we had to transfer sound from the dictation from Tromsø to Sætermoen ... And it was perhaps so early that there were not so many good alternatives. So, we felt we had a very good solution like this is needed at the hospital in Tromsø and other places."

However, the complexity of the project was also obvious for the employees.

"*Then we got the challenge in data to transfer documents and that kind of files safely. It was something you did as a pilot, but we had no experience."*

One of the challenges was to gather all the information, relevant to the patient living outside the town, that had to be sent over many kilometres, received in Radiology Department. This information, however, did not only include pictures, but also text and sound-files that were also meant to be shared safely between hospitals. And all this data should have been transferred with a high level of security.

The fact of creation of the solution in itself was a breakthrough and, as expressed by informant 1, turned out to be the first fully digitalized Radiology Department in the world. Here is what was shared:

> *"Looking at things retrospective, it was the first full-digitised r-department in the world. The reason why I can say today is that all the other digitised departments ... all the other university clinics that post that they had established PAC's digital solutions earlier ... they had probably did just a segment of the department ... or activity. What was special for us is that we did is a complete digitization of the entire department. Absolutely everything. We were for sure the 1st in the world to digitise a University Hospital in the center, connected to 11 local hospitals. We become the first regional digital radiology network in the world."*

The ambitious aim was achieved, but initially the project at UNN was also met with scepticism among stakeholders. As informant 3 shared:

> *"No one thought this was possible."*

As informant 1 also shared:

> *"Those who were most enthusiastic, in addition to the doctors who were with me, was the IT staff in the hospital. They were full of enthusiasm and believed that this was the future and that this was a good solution. And of course, those from Televerket, who worked technically, they were also very positive."*

Back in the 90s technological development was not on the same advanced level as it is now. It was a challenge for developers who were working with clinical solutions, as expressed informant 5:

"Before, you were very much more dependent on writing all the code yourself. We had a very small library and help that he could use to retrieve code. Now you have a much bigger ... a much larger toolbox to take. There are many components that you can retrieve and that you can use instead of writing all the code yourself. After all, you have tools that are much more advanced, much easier to use. But at the same time, end products are much more complicated. (...) The end product was much simpler than it is today. So, that changes in many ways."

The motivation to develop a solution and enthusiasm to solve the existing problem despite challenges, following the ANT, can be seen as an actant and seems to play a significant role in the process of development. Without this element, the solution and even the development process in itself could have followed another path or never be in place at all.

4.4 Being effective, Agile and build MVP as a core principle

According to the research participants, the new project was also aimed to prove that investments are worth it. Therefore, the economic effectiveness of the project was required to be proven. As shared by key informant 1:

"We were the department that had an increase in the number of employees of 2%, while in the hospital in general there was about 13% during that period. So we had a significant increase in production, what we call it ... efficiency. No need to add more staff. (...) We managed to do a total implementation of a new system throughout the hospital and did this within budget and in a much shorter time."

These economical constraints, as mentioned, could therefore have been a background for the way the solution itself was developed: taking basics first with MVP, iteratively and allowing with quick changes, i.e. being very Agile. As informant 2 shared:

"We used a basic principle: make things easy and minimize all types of costs, implement very fast and test."

Minimum Viable Product or MVP is a development technique in which a new product is introduced in the market with basic features. It allows to "collect the maximum amount of validated learning about customers with the least effort" (Lenarduzzi & Taibi, 2016). Similar approach was taken by the team who worked on digitalizing the Radiology department back in 90s.

It is challenging in its own to develop a system for a local work practice. Therefore, agile development methods such as Scrum and Extreme Programming are used by many software companies. Mapping of user needs, as mentioned before, requires a high degree of user participation. For new development projects, where mutual learning by users and vendors is required, this is especially relevant. While vendors obtain knowledge about the users' work practices, that is expected to ensure high rates of use, users learn about the system's possibilities (Johannessen & Ellingsen, 2009). As informant 1 highlighted:

> *"There were several hospitals that were connected to UNN, and it gave us such a very good opportunity for, wrong to say, test, so we can implement our work pretty quickly. And it gave us confidence that the solution works well, and we provide quick feedback on new things. So that was a very important part of our development in a way."*

4.5 Multidisciplinary team.

The project started with 5-6 doctors only, before the vendor-company was created, as told by informant 1 who was a part of the initial team. Having healthcare professionals, as found out later on, was vital due to the fact that those were the ones to know the context, the challenges with distance and workflow best. As shared by informant 2:

> *"Our experience with project work at (...) was that if there is no driving force at the professional level, from those who are going to use the system, the doctors… then the project is, in principle, going to be a failure."*

Moreover, some IT-professionals from hospital IT Department have already had some contact with the Radiology Department and therefore already had an understanding of the internal workflows. As informant 5 shared:

> *"I started to work at University Hospital in Tromsø at the Radiology department. And it was such a way to get in touch with the development of RIS and patient administration systems. (...) I worked closely with the one who was the Head of Department. It was him who was in one way my boss, and I have never been such a person who has not taken up the task himself, but not so big, but that I took the tasks I got. He was a lot around the ward, was in when other patients were examined to help and somehow got a little hospital under the skin. It is quite an exciting place to work, it is amazing when you realize that here is really about life. You understand that it really matters that that data solution works. So even though I have no health-related background, I felt that I got a very good*

training through what I got at the hospital. Since we worked with RIS, we worked also with PACS and various modalities."

So, the IT professionals from UNN were also involved, having an internal knowledge of the routines to a certain degree, connection to the doctors and experience working with hospital IT systems. IT-professionals from Det Norske Televerket were also involved, having a crucial technical knowledge.

Informant 1 explains:

"We had the hospital's own IT department people who ensured that we got into collaboration with Det Norske Televerket, internally and externally. The hardware and different components were supposed to be on both the Setermoen at Troms hospital and UNN."

The IT-expertise was in high demand because the technological foundation for making the idea come true was not established.

"Det Norske Televerket with its resources was absolutely necessary to get the technical solution in place. We had no reading station for pictures at all. It was also a routine. Together with Det Norske Televerket, we built a those station for x-ray pictures." – as shared by informant 1.

Healthcare professionals at Radiology department, IT-professionals from the hospital teamed up with "Det Norske Televerket" and started to work together. Having this common and shared understanding of the tasks, workflows and giving an insight view of the needs of the system users. As shared by informant 6:

"In all the startups and companies I have been with, the success factor is to have a close and tight dialogue with the users who knows their needs and professionals who can do their business."

Informant 5 expressed that having that unique mix of competence meant a lot for the development and maintenance of the solution:

"It was crucial, that we not only had top educated people from IT, we had people who have worked in the Radiology department who understand workflow and challenges."

Majority of frameworks analysed by van Germert-Pijnen et al. recognise the crucial role of a multidisciplinary approach for development, systematic and continuous evaluation during development, that result in technologies reflecting the environmental aspects and needs of their

users. A multidisciplinary approach within IT in healthcare is defined as involvement of different disciplines, with a team of various experts, guiding development of ehealth technologies. It also includes contributions of various stakeholders affected by the use of the ehealth technologies. A multidisciplinary development team of experts from various sciences as social, management, and legal should be part of the team, those can reuse theories of sociology and economics, epidemiology and systems science though application of those to health care evaluation. It is believed to help to maximize the ehealth's potential. Organization of the development process and identification of the skills and employees necessary to implement ehealth technologies – are among the roles and responsibilities of that multidisciplinary team. Organization of the data collection (research) and the process of involving stakeholders (communications) should be allocated between identified roles and responsibilities for that roles. Ensuring that values, drivers and goals of the ehealth technologies are reflected in development is the main reason why stakeholders should be considered as important contributors to the multidisciplinary team. Stakeholders' requirements, worries, values, opinions and beliefs, should be thoroughly understood, that will help to define what the system is expected to be developed and implemented (van Gemert-Pijnen et al., 2011). All this creates an environment of mutual learning from each parties and communication between them, that is a basis of co-development described in next paragraph.

4.6 Co-development.

Digital x-ray images were adopted following the initiative of x-ray healthcare professionals at the hospital in Tromsø in close collaboration with another important actor in the network, constituting the vendor, namely Televerket, and Televerkets's early investment in telemedicine. It was a truly co-creation project that included several parties that worked together.

Another interesting aspect of the product development was not only that healthcare professionals saw the need to make a product, not only were part of the initial start of development but kept a significant power during and after the first product was developed and delivered. Interviewees shared that there were several reasons for that. As informant 4 shared, the knowledge about internal workflows and close connection to end-users was important:

> *"The fact that they (founders of the product) came from the hospital means that the employees, who were with us further, had a very close relationship with other employees in the hospital. So that it was in a way very easy for us to use the hospital afterwards to test for piloting other things etc, considering the fact that we were very well known there."*

Keeping healthcare professionals as full-time employees in the product development was also a strategy that helped to gain insight knowledge about a specific field of x-ray imaging and Radiology Department. As shared by informant 6:

> *"They did not only have a very good knowledge of the products, which they have helped to develop, but also how hospital runs. Because they have worked in hospitals. And this is something we have consciously done further, when we have recruited new people."*

As mentioned earlier, once the MVP was made, it was implemented and tested out. The new updates and functionality were resulting in quick tests and feedback. But why this iterative way of development was possible at the first place? The data from interviews suggest that the team members' background and the close relationship to the hospital and its staff had a significant effect.

The physical location of the team, experience with working at UNN before and a motivated project manager were the ones to support the development process, as expressed by one of the respondents:

> *"Generally, in terms of development, it was incredibly good because you got very direct feedback: you had to shut up if things didn't work and were not good. And you got (---) when things were good. And you were like that up to you ... you could somehow not make changes that were not accepted. Project manager was also used all the time to just push things straight into production. We worked in a special way, so that it was very short time before we wrote the finished code until it was put into production then. So, yes. It was very good to work against the doctors and they gave good feedback. (...) We knew the hospital the hospital knew us."* – as informant 5 shared.

Healthcare professionals were involved in a continuous feedback loop. As informant 6 said:

> *"The medical team could suggest a change, then those who programmed the solution came to the department to listen to the suggestions."*

The connection between end-users and those who develop a solution was extremely close, as one of the interviewees remembers that he could call the developer and ask for changes directly:

> *"I could just call and say "(...) listen, you must do something with this!" And it was done immediately!"* - informant 5 remembers.

The testing and the feedback from end-users was also a quality check and a "green light" to develop the solution further, as expressed by informant 3 (check):

"There were quite a few hospitals that were part of UNN, and so it gave us very good opportunity, wrong to say, to test. Those tests gave us the confidence that the solution works well and we quickly respond to new things."

According to the human-computer interaction, users should be involved in the design in order to create more relevant technologies. User-participation is more likely to result in the wide acceptance of participatory design approaches and importance of user-centred design (Granja, Janssen & Johansen, 2018). As highlighted in a research by S. Martikainen and colleagues (2012) getting an understanding of the healthcare work practices, where the information systems will be used, should be the initial step in development process. Clinical work and processes have features that are characteristic to the healthcare delivery domain: varied and dynamic working practices, a high volume of communication and collaboration among professionals, governmental and professionals regulations. Therefore, in healthcare IT development those are critical for consideration, so IT systems and work processes should be developed at the same time. Guidelines can be used during healthcare information system development to avoid the dissatisfaction and abandonment of developed solutions. Research shows that systems, developed in accordance with the principles of user-centred design, have a better EHR adoption and integrated use rates. If healthcare personnel finds the systems helpful and useful, it is believed that physicians will become more enthusiastic with it comes to using IT (Martikainen, Viitanen, Korpela & Lääveri, 2012). It can be therefore claimed that the design and the outcomes of ehealth are clearly related. Therefore, the importance of user involvement during the design stage cannot be underrated (Granja, Janssen & Johansen, 2018).

In new product development, iterative rapid-cycle "agile" methods prove more effective than a traditional "waterfall" approach. Such products provide value earlier, mitigate risks sooner, and incorporate customer/user feedback to iteratively adapt and evolve, becoming more fit for real-world use. Agile methods should be equally applicable to innovative healthcare technology development projects. Co-development between builders and customers is one key agile concept for iteratively better meeting customer/user needs (Kannan et al.; 2017). It has been argued that end-user involvement is one of the most important success factors in end-user satisfaction and quality in IT projects (Martikainen, Korpela, Tiihonen, 2014).

4.7 Keeping the close contact with customers

The continuous feedback from end-users was not only used during the development and implementation. These close relations with end-users were also reflected on how the company

worked with its future customers. Though the company then got private-owned customers, the co-creation with end-users was taken seriously, as remembered by several interviewees:

> "*We have a very close and good dialogue with our customers. That is proven by their needs, and we have developers who have a professional basis for developing and delivering what customers want*." – shared by informant 6.

Informant 4 also mentioned keeping a close dialogue with a customer and end user as crucial, creating more human-human relations and feeling of involvement and ownership.

> *"It has also been incredibly important. We have never had so many customers that they have lost contact with customers in a way. We have a personal relationship with the customer we have had. And it has been very important to us it would have been perhaps one of our most important success factors. That customers have really felt like we have listened to them and when they have made suggestions and wishes. And so we managed to realize it in a relatively short time. So, it has been very important to us. I think to be able to feel some ownership in the product and to feel that if things you are dissatisfied with then get them through for some of those thoughts."*

This kind of work is recommended to be carried out over a proper amount of time. Sometimes it may take years for benefits and outcomes to appear. Moreover, following developments over the long time period can be used to identify when systems have become out-dated and when there is a need to develop new solutions to replace or add to older ones (Cresswell, Bates & Sheikh, 2013).

4.8 Training and continuous feedback

Training and support during implementation of developed products is one of the main issues and research topics in healthcare IT nowadays. Training was provided due to the shift from the current install base, so digitalizing the whole department required an excessive learning of healthcare professionals. It was seen as an integral part of the implementation, and informant 5 shares:

> *"When we were digitalized… the day we were digitalized, we had 1 person behind every single radiologist. They were there to help us to learn the program. (…) We had a hands-on learning and this learning lasted for weeks, until everything was working properly. It was unbelievable."*

User who got training have a tendency to be more satisfied with new technologies compared to those who did not got trained or the training wasn't sufficient. It is believed that new systems can be used in unintended ways or even avoided to be used completely night be due to lack of understanding of system possibilities (Cresswell, Bates & Sheikh, 2013). Therefore, it is fair to say that training plays a crucial role in perception and use of ehealth solutions in healthcare.

In order for training to be more effective, it is recommended to be not restrictive, giving a better understanding of how the whole system functions. It should certainly be tailored to the individual roles of users, be 'hands-on', close to real practice as possible, simulating the actual working environment as possible. Timing of training is also important: conducting training sessions just before the implementation of the solution helps to make sure participants remember the learned skills and materials. Training can include both mandatory and voluntary components. Some individuals may need a more extensive training than others, for example older users who may not have a decent level of PC literacy at all. Continuous training may also be necessary for users who do not use the system as often. This is especially necessary if the system or solution are getting upgrades (van Gemert-Pijnen et al., 2011).

4.9 Keeping the old traditions that work

A commercial company was a required move to expand the operations of the small team within the Radiology Department at UNN, that at the end gradually moved to office out from the hospital. As informant 4 shared:

> *"We were given responsibility for employees and products and all other commitments to the product, as well as to operate this solution from UNN."*

This, however, did not radically changed how the core principles of how the team was working: keeping contact with end users, had multidisciplinary team and quick iterations.

5 Discussion

This master thesis attempted to understand how a small private health IT company approached the development of clinical ehealth solution in the context of the Norwegian healthcare digitalisation. ANT helps to theorize how different actors experience and behave in various realities. This helps to consider the relations between different actors and get a more comprehensive picture of their dynamic interactions. (Cresswell, Worth & Sheikh, 2010). This approached was helpful to identify the actors and actants to gain insights into the network that were involved in the development process of the ehealth solution that took place in RiTø. The following paragraphs reflect on the actants and their role in the described in the findings process.

5.1 Location

Things and objects, according to ANT, are "actants" and therefore have the potential to transform and facilitate social relationships (Cresswell, Worth & Sheikh, 2010). In this case, location was an important actant in many ways.

North-Norway can be described as a region with a scattered population and a scarcity of health service specialists, mostly located in Tromsø (Helsedirektoratet, 2018). This was a perfect starting point to offer specialist services in the rural districts and develop telemedicine in Tromsø. Inhabitants living in rural and remote areas in the Arctic region, therefore Northern Norway has a unique context when it comes to using IT in healthcare (Walderhaug, Granja, Horsch & Hartvigsen, 2015). The Northern Norway Region, and Tromsø particularly, was a pioneer when it comes to telemedicine and ehealth (Sosial- og helsedepartementet, 2020). As mentioned before, visionary politicians, health administrators, healthcare professionals and researchers saw the possibilities to offer high quality healthcare to everybody, irrespective of where they live (Walderhaug, Granja, Horsch & Hartvigsen, 2015).

The hospital itself was also an epicentre of innovation and experimentation. The Research and Development (R&D) department at the Norwegian telecommunication company Telenor initiated research on pilots in telemedicine in the region and soon moved to Tromsø as the University Hospital of North Norway (UNN) has a reputation for being open to new ways of addressing the challenges of the rural region of Norway. Since the late 1980s, UNN has experience in the following areas: teleradiology, telepathology, teledermatology, teleotorhinolaryngology (remote endoscopy), remote gastroscopy, teleechocardiography, remote transmission of ECGs, telepsychiatry, teleophthalmology, telenephrology/-dialysis,

teleemergency medicine, teleoncology, telecare, telegeriatric, teledentistry, maritime telemedicine, referrals and discharge letters, the electronic delivery of laboratory results and remote teaching for healthcare personnel and patients (Hartvigsen et al., 2007).

This, in addition to the enthusiasm of hospital employees and stakeholders to have a new solutions in place, makes it very clear why the solution's development took place exactly in North Norway and RiTø.

5.2 Agile and Design Thinking.

The way the development was done deserves to be an actant too, as the development team, even when it was commercialised, seemed to be practicing the agile methodology and Design Thinking. Those principles are on the rise lately and used by companies to increase their innovation capacity and strategies (Diderich, 2020).

Since the development was done alongside with a lot of challenges and scepticism, the approach that the vendor tool is to start, build quickly and get continuous feedback. This seemed to be a useful approach when needed to prove that idea is worth to work on fast by showing the results of the work and ever-improvement of the solution with small iterations. This approach is very similar to Design Thinking.

Reflecting on the steps in Design thinking mentioned in the Theory chapter, it becomes clear how the vendor approached the agile development in practice. *Discover*. The Radiology Department at the regional hospital RiTø's was required to be able to transfer X-ray pictures from the hospitals in Nordland, Troms and Finnmark to the main radiology department of the hospital, located in Tromsø. (Hartvigsen, 2016) There was a great need and motivation to get a digital solution in place that could help both healthcare professionals and patients, making the logistics around x-ray pictures more efficient. In the case of the vendor, this phase was initiated and conducted by informant 1 and co-workers, who travelled long distances and saw the need for a more sustainable way of delivering services.

Define. Exactly this fase correlates with the stage when the proposed solution was started to be discussed and different stakeholders. Healthcare professionals at Radiology department, IT-professionals from the hospital teamed up with "Det Norske Televerket" and started to work together. Having this common and shared understanding of the tasks, workflows and giving an insight view of the needs of the system users.

Prototype. The new project was also aimed to prove that investments are worth it. Therefore, the economic effectiveness of the project was required to be proven. These economical constraints, as mentioned, could therefore have been a background for the way the solution itself was developed. The taken approach was to make things work simply, quick and in a form of MVP.

Test. MVP was made, it was implemented and tested out. The new updates and functionality were resulting in quick tests and feedback. The physical location of the team, experience with working at UNN before and a motivated project manager were the ones to support the development process in a close relation with clinicians. The testing and the feedback from end-users was also a quality check and a "green light" to develop the solution further. Then the loop started again, adding more functionality and features or adjusting the existing one.

It is important to consider the challenges that healthcare settings present, while assessing whether Design Thinking provides added benefit compared to traditional approaches. Healthcare settings are special and may not have the same challenges as other domains, where Design Thinking is used more often (Altman, Huang & Breland, 2018). For this particular case, agile methodology and Design Thinking played a significant role as an actant in the development process of the solution. They served not only the solid way of development of something completely new, but took it on another level and showed the way of working on healthcare solutions together with healthcare professionals – co-creation.

5.3 Co-creation and user-involvement.

Co-creation seems to be yet another crucial actant in the network, as it was a core principle across the whole history of the solutions development. Without co-creation, the project might have not been adopted and implemented, as, according to the literature, it plays a significant role and should be a golden rule for development and implementation of the clinical IT solutions.

Many efforts at digitalisation of healthcare have not fulfilled their potential, at least in the field of patient care, since clinicians are dissatisfied with healthcare information systems. IT systems in healthcare do not produce the expected healthcare benefits, raising the question for policymakers if such systems will improve quality, efficiency and safety at all (Greenhalgh et al., 2009; Greenhalgh & Stones, 2010). Furthermore, such systems are experienced as disruptive and inefficient by clinicians. Dissatisfaction with the impact of IT systems in

healthcare on workflow and patient throughput are still high, despite usage rates to be also reported high, at above 90% (Lintern & Motavalli, 2018).

An intervention is more likely to reach its goals if technological, human and contextual factors are forming a good fit in the development process. This means that developers should consider ehealth as creating an infrastructure to support healthcare delivery and its organisation, dissemination of knowledge and communication using technology, rather than a tool to achieve certain results. Then it's possible to follow the framework that supports the development of such an ehealth technology using existing approaches with participatory development, business modelling, human-centred design and persuasive technology (Gemert-Pijnen, Kelders, Kip & Sanderman, 2018).

Established study results and challenges in system development are the source of growing interest towards end-user issues in health informatics (Martikainen, Viitanen, Korpela & Lääveri, 2012) Over the past four decades user involvement in software development was considered as one of the central factors to play a positive role in accomplishing system success. Users are typically involved in early stages of development for requirements gathering and obtaining feedback in the process of software development. Involving users throughout the software development lifecycle is considered crucial due to the increasing number of project failures because of user dissatisfaction. By involving users, solution developers can achieve user buy-in, support, that can levitate the change for solution implementation and project success (Bano & Zowghi, 2013).

However, studies on user involvement show inconsistent results. Reason for that could be that a term "user involvement in software development" is a very abstract and there is no common definition of users, involvement and software development. Users' roles vary in different roles within one or many organizations. Software development lifecycle has numerous phases and activities, depending on technological changes, chosen methodologies, application domains. The use of term "involvement" is inconsistent that leads to uncertainty, which makes the meaning and usage of this word to remain undistinguishable. Moreover, the term "user engagement" refers to both involvement and participation and is also used in the literature (Bano & Zowghi, 2013).

Actively involving proposed users through participatory design processes has conventionally been emphasised in IT design (Dugstad, Eide, Nilsen & Eide, 2019). Healthcare information technology development isn't an exception and should involve stakeholders, including

healthcare personnel. This is a prerequisite for better clinician and patient initial adoption, fitting the complex and evolving environment, when developing a new technology or feature (Martikainen, Viitanen, Korpela & Lääveri, 2012). Ehealth technology development is a matter of co-creation, where end-users are playing a significant role. User-centred design helps to develop concentrate on developing a detailed representation of the user's perspective and silmultaniously help the users to recognise their importance in design and development process (Ahmed, Dannhauser & Philip, 2019; Handayani, Hidayanto & Budi, 2018).

Industries and field like economics, marketing and business used engagement of end-users in the development and design of products and services to make products more appealing, increase consumer loyalty and get more efficient marketing. This was practiced for years. Therefore, funding and governing bodies are more than ever encouraging the involvement of end-users and stakeholders in the co-creation of public health interventions and health promotion campaigns. The extent of end-user engagement can vary and be anything from obtaining end-user feedback on a product designed by an skilled designer, further using co-creation approaches involving all actors for knowledge contribution throughout the development process, to meta-design which is initiated and controlled exclusively by end-users (Leask et al., 2019). Information about the application domain, the tasks performed, work practices, context of the system use as well as can description of their behaviour and preferences – is something that users typically can provide. This form of knowledge is often hidden and difficult to be obtained. User involvement in SDLC simplifies the process of understanding of their work environment, making them more aware of it. This process can improve the quality, accuracy and completeness of their requirements (Bano & Zowghi, 2015). Prior studies have reported that end-user participation leads to good user acceptance and has positive impacts on work practices, that is essential to overall success of ehealth interventions (Tapanainen, Dao, Nguyen, Eikebrokk & Moe, 2016). Findings from systematic review by Ross et al also support the idea that factors affecting implementation success such as adaptability, complexity, individual characteristics and engaging may be addressed by involving the end-user into the design and development process of the ehealth solution (Ross, Stevenson, Lau & Murray, 2016; van Gemert-Pijnen et al., 2013).

Few systematic studies have been done to investigate the effects and practices on user involvement in in healthcare IT development, despite the relevance of and need for a user-oriented approach to be widely established and argued. Main benefits of user involvement are related to an increased access to user needs and experiences, improvements in the functionality,

enhancements in design and user interfaces, better usability, quality of applications. However, lack of understanding and appropriate knowledge about methods to be used, poor communication and cooperation between users and developers, lack of resources, attitudes of technical developers can be key inhibitions in involving users. It has also been argued that there is a need for designers with user interface and interaction design skills to be involved in healthcare IT system development (Martikainen, Viitanen, Korpela & Lääveri, 2012).

As mentioned earlier of multidisciplinary approach for development and systematic and continuous evaluation during development plays an important role and result in technologies reflecting the environmental aspects and needs of their users. A multidisciplinary approach helps different disciplines to be involved as team of various experts, guiding development of ehealth technologies. It also includes contributions of various stakeholders affected by the use of the ehealth technologies. Some frameworks advocate to even include patients during the development process (van Gemert-Pijnen et al., 2011). Involving stakeholders from different backgrounds and using co-creation process in ehealth development helps to take into account different interests and create trust, ownership, commitment, organize resources and capacities for development work (Palokangas, 2017). The role of that whole network can't be underestimated as members of the network are a source of information for documenting the complex relationships between political, social, organizational, and technical worlds. The shared knowledge helps to ensure that different contexts and visions are taken into account, identify the values and concerns different stakeholder have and develop sustainable ehealth technology programs (van Gemert-Pijnen et al., 2011). Actors that are recommended to be a part of the multidisciplinary team are from clinicians/health care provision, technology development and health service research, payers, purchasers, policy makers, lawyers, and consumers/end users (such as patients, families, and caregivers) representing clinical, technical, financial, administrative, organizational, human, social and political groups (van Gemert-Pijnen et al., 2011).

Collaboration between clinicians and IT professionals is considered to be one of the biggest opportunities in the future of healthcare. (Ahmed, Dannhauser & Philip, 2019).

6 Conclusion

The ANT approach helped to identify that when it comes to implementing digital technology in hospitals, the region of North Norway and the Regional Hospital of Tromsø (RiTø) (now - UNN), are standing out. Radiology has been a routine service at UNN for many years, but when the hospital got a status of regional, it started to serve patients who were not only living in Tromsø, it included patients in Norland, Troms, Finnmark and Svalbard. This, was a perfect circumstance to start the rollout and development of solutions to overcome distance, i.e. ehealth solutions. The vendor company chosen as a case for this research was a unique example of how the internal innovation work from healthcare personnel can become a pioneer in the field. The developed teleradiology system was the world's first large-scale solution with image transmission and requisition / response logistics in continuous operation. The solution was later commercialized and was among the first of several successful launches from the Tromsø environment (Hartvigsen, 2016).

The findings also show that agile methodology and Design Thinking happen to be an actant in the network involved in the development process. Design Thinking process described in the discussion part of the master thesis shows how the vendor approached it. First – the development of the solution started with identifying the pain-points of the way the services were offered, need to be fulfilled, problem to be fixed. The process of healthcare delivery was cumbersome and wasn't efficient enough for radiologists to serve several hospitals. Second – the definition of the solution if not was completely in place, but the essential parts of it were. A new system to be developed should be both fit for organizational purpose and fit for clinical practice, the ideators behind the solution were familiar with both. Moreover, the team had big ambitions and were able to include several key stakeholders into the process of creating the solution. This helped to make the solution development multidisciplinary, from the very beginning. This also makes the development of the solution unique: back in 90-s the team practiced the approaches that have become popular just recently. The third aspect was ability to make things fast, covering the fundamental functionality and invest in essentials rather than making the solution unnecessary big and complex. This MVP approach helped to roll it out quickly and step into the last phase of Design Thinking. Fourth and last aspect – testing. The solution and the way it fit the organisation and clinians' reality could be immediately checked and tested out, so the team behind the solution could make adjustments.

All four aspects (actants) mentioned above have a red thread going through all – very close cooperation and inclusion of clinicians in the solutions development process. This, according to the analyses of collected data, was also an actant and played a significant role in the development of the solution. The abovementioned approach is often referred as user involvement, participatory design, activity analysis, and user- or human-centred design and development, co-creation. Traditional IT development, as demonstrated in paragraph 2.3 adopts a systematic approach for conducting analysis, design and testing, without necessarily using a specific user model. Nowadays, researchers agree on the central role of user-involvement in software development process, especially healthcare (van Gemert-Pijnen et al., 2011; Ahmed, Dannhauser & Philip, 2019). The examined literature consequently emphasises the significance of the role of end-users and therefore highlights the importance of user-centred design, that is, to develop an improved appreciation of the design and development process from the user's point of view and to focus on developing a detailed representation of the user's perspective (Ahmed, Dannhauser & Philip, 2019; Handayani, Hidayanto, & Budi, 2018). Users are an important source of design information and should be seen as a natural part of the design process in order to ensure technology to be useful, usable, elegant and desirable. Findings from systematic review by Ross et al also support the idea that factors affecting implementation success such as adaptability, complexity, individual characteristics and engaging may be addressed by involving the end-user into the design and development process of the ehealth solution (Ross et al., 2016).

It would be fair to say that the whole network of actants turned out to play its role and help to shape the development approach of the chosen vendor. This master thesis illustrates how a small vendor in North Norway continued to carry on the established user-involvement practices and worked in very close cooperation with clinicians in the solutions development process for years starting in1990s. This cooperation with end-users was a natural part of the whole development process and was a necessary approach in order to tackle the challenges to be solved in a special context of healthcare in North Norway.

7 Limitations

The limitation in this master thesis is its nature: qualitative exploratory case study. I, as a researcher, did my best to maintain transparency throughout out this thesis by following a theoretical framework and acclaimed principles for robust qualitative research, despite the fact that I have been in contact with some research participants before the research started. It is also possible that the empirical data would be different if the study was conducted at a different time and in a different setting. The vendor company was sold right after the research was finished, so this study has not considered the way company operates now, and how this might affect development of the solution.

Further research should be of a wider scope and aim towards a more comprehensive understanding of how the development process is done in several cases and include more aspects of development process to be included in the analyses.

8 Literature

Ahmed, B., Dannhauser, T., & Philip, N. (2018). A systematic review of reviews to identify key research opportunities within the field of eHealth implementation. Journal Of Telemedicine And Telecare, 25(5), 276-285. doi: 10.1177/1357633x18768601

Al-Busaidi, Z. Q. (2008). Qualitative research and its uses in health care. *Sultan Qaboos University Medical Journal*, *8*(1), 11.

Alshamrani, A., & Bahattab, A. (2015). A comparison between three SDLC models waterfall model, spiral model, and Incremental/Iterative model. *International Journal of Computer Science Issues (IJCSI)*, *12*(1), 106.

Altman, M., Huang, T., & Breland, J. (2018). Design Thinking in Health Care. *Preventing Chronic Disease*, *15*. doi: 10.5888/pcd15.180128

Andreassen, H., & Trondsen, M. (2015). How to use qualitative interviews in E-health research. In *Proceedings of the 17th International Conference on eHealth, Telemedicine, and Social Medicine: eTELEMED, Lisbon, Portugal* (pp. 22-27).

Ash, J. S., Sittig, D. F., Campbell, E. M., Guappone, K. P., & Dykstra, R. H. (2007). Some unintended consequences of clinical decision support systems. In *AMIA Annual Symposium Proceedings* (Vol. 2007, p. 26). American Medical Informatics Association.

Bannon, L. J., & Schmidt, K. (1989). CSCW: Four characters in search of a context. In *ECSCW 1989: Proceedings of the First European Conference on Computer Supported Cooperative Work*. Computer Sciences Company, London.

Bano, M., & Zowghi, D. (2013). User involvement in software development and system success: a systematic literature review. In *Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering* (pp. 125-130).

Bano, M., & Zowghi, D. (2015). A systematic review on the relationship between user involvement and system success. *Information and software Technology*, *58*, 148-169.

Bashir, M., Afzal, M., & Azeem, M. (2008). Reliability and Validity of Qualitative and Operational Research Paradigm. *Pakistan Journal Of Statistics And Operation Research*, *4*(1), 35. doi: 10.18187/pjsor.v4i1.59

Benson, H. (2005). Chaos and Complexity: Applications for Healthcare Quality and Patient Safety. *Journal For Healthcare Quality*, *27*(5), 4-10. doi: 10.1111/j.1945-1474.2005.tb00571.x

Berg, M. (1999). Patient care information systems and health care work: a sociotechnical approach. *International Journal Of Medical Informatics*, *55*(2), 87-101. doi: 10.1016/s1386-5056(99)00011-8

Berg, M., Aarts, J., & van der Lei, J. (2003). ICT in Health Care: Sociotechnical Approaches. *Methods Of Information In Medicine*, *42*(04), 297-301. doi: 10.1055/s-0038-1634221

Carroll, N., Richardson, I., & Travers, M. (2017). Uncovering Key Factors for a Hospital IT Change Strategy. In *HEALTHINF* (pp. 268-275).

Coiera, E. (2009). Building a National Health IT System from the Middle Out. *Journal Of The American Medical Informatics Association*, *16*(3), 271-273. doi: 10.1197/jamia.m3183

Cresswell, K., Bates, D., & Sheikh, A. (2013). Ten key considerations for the successful implementation and adoption of large-scale health information technology. *Journal Of The American Medical Informatics Association*, *20*(e1), e9-e13. doi: 10.1136/amiajnl-2013-001684

Cresswell, K., Worth, A., & Sheikh, A. (2010). Actor-Network Theory and its role in understanding the implementation of information technology developments in healthcare. *BMC Medical Informatics And Decision Making*, *10*(1). doi: 10.1186/1472-6947-10-67

Cypress, B. S. (2015). Qualitative Research: The “What,”“Why,”“Who,” and “How”!. *Dimensions of Critical Care Nursing*, *34*(6), 356-361.

Dankert, R. (2011). Using Actor-Network Theory (ANT) doing research. Retrieved 3 May 2020, from https://ritskedankert.nl/using-actor-network-theory-ant-doing-research/

deMarrais, K. B., & Lapan, S. D. (2003). Qualitative interview studies: Learning through experience. In *Foundations for research* (pp. 67-84). Routledge.

Diderich, C. (2020). *Design Thinking for Strategy*. Cham: Springer.

Drosatos, G., Kavvadias, S. E., & Kaldoudi, E. (2017). Topics and trends analysis in ehealth literature. In EMBEC & NBC 2017 (pp. 563-566). Springer, Singapore.

Dugstad, J., Eide, T., Nilsen, E., & Eide, H. (2019). Towards successful digital transformation through co-creation: a longitudinal study of a four-year implementation of digital monitoring technology in residential care for persons with dementia. *BMC Health Services Research*, *19*(1). doi: 10.1186/s12913-019-4191-1

Farquhar, M. A. (2008). *Actor Networks in Health Care: Translating Values into Measures of Hospital Performance* (Doctoral dissertation, Virginia Tech).

Gemert-Pijnen, L., Kelders, S., Kip, H., & Sanderman, R. (2018). *eHealth research, theory and development*. London: Routledge, Taylor & Francis Group.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The qualitative report*, *8*(4), 597-607.

Granja, C., Janssen, W., & Johansen, M. (2018). Factors Determining the Success and Failure of eHealth Interventions: Systematic Review of the Literature. *Journal Of Medical Internet Research*, *20*(5), e10235. doi: 10.2196/10235

Greenhalgh, T., Potts, H. W., Wong, G., Bark, P., & Swinglehurst, D. (2009). Tensions and paradoxes in electronic patient record research: a systematic literature review using the meta-narrative method. *The Milbank Quarterly*, *87*(4), 729-788.

Greenhalgh, T., Stones R. (2010). "Theorising big IT programmes in healthcare: strong structuration theory meets actor-network theory." *Social science & medicine* 70.9 : 1285-1294.

Greenhalgh, T., Wherton, J., Papoutsi, C., Lynch, J., Hughes, G., & A'Court, C. et al. (2018). Analysing the role of complexity in explaining the fortunes of technology programmes: empirical application of the NASSS framework. *BMC Medicine*, *16*(1). doi: 10.1186/s12916-018-1050-6

Handayani, P. W., Hidayanto, A. N., & Budi, I. (2018). User acceptance factors of hospital information systems and related technologies: Systematic review. *Informatics for Health and Social Care*, *43*(4), 401-426.

Hanseth, O., & Monteiro, E. (1998). Understanding information infrastructure. *Unpublished Manuscript, Retrieved on 6th September from http://heim. ifi. uio. no/~ oleha/Publications/bok. pdf*.

Harrison, M., Koppel, R., & Bar-Lev, S. (2007). Unintended Consequences of Information Technologies in Health Care--An Interactive Sociotechnical Analysis. *Journal Of The American Medical Informatics Association*, *14*(5), 542-549. doi: 10.1197/jamia.m2384

Hartvigsen, G. (2016). Tromsø – Norges hovedstad innen forskning på IKT i helsesektoren. Retrieved from https://nordnorskdebatt.no/article/tromso-norges-hovedstad-innen

Hartvigsen, G., Johansen, M. A., Hasvold, P., Bellika, J. G., Arsand, E., Arild, E., ... & Pedersen, S. (2007). Challenges in telemedicine and eHealth: lessons learned from 20 years with telemedicine in Tromso. *Studies in health technology and informatics*, *129*(1), 82.

Helse Nord. (2014). Styresak 36-2015/8. E-post med vedlegg av 18. mars 2015 fra overlege Jan Størmer, UNN Tromsø ad. Etterlysning av svar. Helse Nord. Retrieved from https://helse-nord.no/Documents/Styret/Styrem%C3%B8ter/Styrem%C3%B8ter%202015/20150326/Styresak%2036-2015-8%20E-post%20med%20vedlegg%20av%2018.%20mars%202015%20fra%20overlege%20Jan%20St%C3%B8rmer.pdf

Helsedirektoratet. (2018). *Leger i kommune- og spesialisthelsetjenesten. Rapport 2018.* Oslo. Retrieved from https://www.helsedirektoratet.no/rapporter/leger-i-kommune-og-spesialisthelsetjenesten/Leger%20i%20kommune-%20og%20spesialisthelsetjenesten.pdf/_/attachment/inline/da39ed65-f77e-453e-b968-c7dc50c00328:e35719d53334b1ed7cad7ad736f4d6bd22f1339f/Leger%20i%20kommune-%20og%20spesialisthelsetjenesten.pdf

Hurlen, P. (2012). Teleradiologi - muligheter og utfordringer. *Tidsskrift For Den Norske Legeforening*, *132*(23), 2622-2624. doi: 10.4045/tidsskr.12.0876

Høyland, S., Hollund, J., & Olsen, O. (2015). Gaining access to a research site and participants in medical and nursing research: a synthesis of accounts. *Medical Education*, *49*(2), 224-232. doi: 10.1111/medu.12622

IAMOT 2018 Conference Proceedings. (2018). SOCIOTECHNICAL CONSIDERATIONS FOR HEALTH INFORMATION TECHNOLOGY DESIGN AND IMPLEMENTATION IN COMPLEX AND ADAPTIVE HEALTH SYSTEMS. In *International Association for Management of Technology*.

Johannessen, L. K., & Ellingsen, G. (2009). Integration and generification—agile software development in the healthcare market. *Computer Supported Cooperative Work (CSCW)*, *18*(5-6), 607.

Johl, S. K., & Renganathan, S. (2010). Strategies for gaining access in doing fieldwork: Reflection of two researchers. *Electronic Journal of Business Research Methods*, *8*(1), 42.

Kannan, V., Basit, M. A., Youngblood, J. E., Bryson, T. D., Toomay, S. M., Fish, J. S., & Willett, D. L. (2017). Agile co-development for clinical adoption and adaptation of innovative technologies. In *2017 IEEE Healthcare Innovations and Point of Care Technologies (HI-POCT)* (pp. 56-59). IEEE.

Kaplan, B., & Maxwell, J. A. (1994). Qualitative research methods for evaluating computer information systems. In J. G. Anderson, C. E. Aydin, and S. J. Jay (Eds.), Evaluating health care information systems: methods and applications (pp. 45-68). Sage, Thousand Oaks, CA.

Kaplan, B., & Maxwell, J. A. (2005). Qualitative research methods for evaluating computer information systems. In *Evaluating the organizational impact of healthcare information systems* (pp. 30-55). Springer, New York, NY.

Konttila, J., Siira, H., Kyngäs, H., Lahtinen, M., Elo, S., & Kääriäinen, M. et al. (2018). Healthcare professionals' competence in digitalisation: A systematic review. *Journal Of Clinical Nursing*, *28*(5-6), 745-761. doi: 10.1111/jocn.14710

Latour, B. (1991). Materials of Power: Technology is society made durable. *A Sociology of Monsters: Essays on Power, Technology and Domination Sociological Review Monograph*, *38*, 103-132.

Law, J. (1992). Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. *Systems practice*, *5*(4), 379-393.

Le.ac, UK. (n.d.). Methods of collecting qualitative data. Retrieved from https://www.le.ac.uk/oerresources/lill/fdmvco/module9/page_54.htm

Leask, C. F., Sandlund, M., Skelton, D. A., Altenburg, T. M., Cardon, G., Chinapaw, M. J., ... & Chastin, S. F. (2019). Framework, principles and recommendations for utilising participatory methodologies in the co-creation and evaluation of public health interventions. *Research involvement and engagement*, *5*(1), 2.

Leau, Y. B., Loo, W. K., Tham, W. Y., & Tan, S. F. (2012). Software development life cycle AGILE vs traditional approaches. In *International Conference on Information and Network Technology* (Vol. 37, No. 1, pp. 162-167).

Lenarduzzi, V., & Taibi, D. (2016). MVP explained: A systematic mapping study on the definitions of minimal viable product. In *2016 42th Euromicro Conference on Software Engineering and Advanced Applications (SEAA)* (pp. 112-119). IEEE.

LeRouge, C., Ma, J., Sneha, S., & Tolle, K. (2013). User profiles and personas in the design and development of consumer health technologies. *International journal of medical informatics*, *82*(11), e251-e268.

Leung, L. (2015). Validity, reliability, and generalizability in qualitative research. *Journal of family medicine and primary care*, *4*(3), 324.

Liebenberg, E. (2020) Human-Centered Design and Innovative Research Methods for Healthcare.

Lintern, G., & Motavalli, A. (2018). Healthcare information systems: the cognitive challenge. *BMC medical informatics and decision making*, *18*(1), 3.

Liu, Z., Su, J., & Ji, L. (2019). Detection and Characterization of E-Health Research: A Bibliometrics (2001–2016). *Scientometrics Recent Advances*. doi: 10.5772/intechopen.88610

Lluch, M. (2011). Healthcare professionals' organisational barriers to health information technologies—A literature review. *International Journal Of Medical Informatics*, *80*(12), 849-862. doi: 10.1016/j.ijmedinf.2011.09.005

Mack, N. (2005). Qualitative research methods: A data collector's field guide.

Mair, F., May, C., O'Donnell, C., Finch, T., Sullivan, F., & Murray, E. (2012). Factors that promote or inhibit the implementation of e-health systems: an explanatory systematic review. *Bulletin Of The World Health Organization*, *90*(5), 357-364. doi: 10.2471/blt.11.099424

Malterud, K. (2001). Qualitative research: standards, challenges, and guidelines. *The lancet*, *358*(9280), 483-488.

Martikainen, S., Korpela, M., & Tiihonen, T. (2014). User participation in healthcare IT development: A developers' viewpoint in Finland. *International Journal of Medical Informatics*, *83*(3), 189-200.

Martikainen, S., Viitanen, J., Korpela, M., & Lääveri, T. (2012). Physicians' experiences of participation in healthcare IT development in Finland: Willing but not able. *International Journal Of Medical Informatics*, *81*(2), 98-113. doi: 10.1016/j.ijmedinf.2011.08.014

Medlineplus. (2020). Imaging and radiology: MedlinePlus Medical Encyclopedia. Retrieved 10 May 2020, from https://medlineplus.gov/ency/article/007451.htm

Merriam, S. B. (1995). What can you tell from an N of 1?: Issues of validity and reliability in qualitative research. *PAACE Journal of lifelong learning*, *4*, 51-60.

Mills, A., Durepos, G., & Wieb, E. (2010). Exploratory Case Study. *Encyclopedia Of Case Study Research*. doi: 10.4135/9781412957397.n139

Munassar, N. M. A., & Govardhan, A. (2010). A comparison between five models of software engineering. *International Journal of Computer Science Issues (IJCSI)*, *7*(5), 94.

Myers, M. (2011). *Qualitative research in business & management*. Los Angeles: SAGE.

Myrvang, R., & Rosenlund, T. (2007). How can eHealth benefit rural areas-a literature overview from Norway. *Baltic eHealth*.
Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence-based nursing*, *18*(2), 34-35.

Norden.org. (2020). Fakta om Norge. Retrieved 14 May 2020, from https://www.norden.org/no/information/fakta-om-norge

Otto, L., Harst, L., Schlieter, H., Wollschlaeger, B., Richter, P., & Timpel, P. (2018). Towards a Unified Understanding of eHealth and Related Terms-Proposal of a Consolidated Terminological Basis. In *HEALTHINF* (pp. 533-539

Palokangas, M. (2017). CeHRes Roadmap utilization in development of eHealth Technology solutions: A Scoping review.

Plsek, P., & Wilson, T. (2001). Complexity science: Complexity, leadership, and management in healthcare organisations. *BMJ*, *323*(7315), 746-749. doi: 10.1136/bmj.323.7315.746
Popay, J., & Williams, G. (1998). Qualitative research and evidence-based healthcare. Journal of the Royal Society of Medicine, 91(35), 32-37.

Pope, C., Ziebland, S., & Mays, N. (2000). Qualitative research in health care: Analysing qualitative data. *BMJ: British Medical Journal*, *320*(7227), 114.

Rinde, E., Nordrum, I., & Nymo, B. J. (1993). Telemedicine in rural Norway.

Roberts, P., & Priest, H. (2006). Reliability and validity in research. *Nursing standard*, *20*(44), 41-46.

Robson, C. (2002). Real world research (2 ed.). UK: Blackwell Publisher.

Ross, J., Stevenson, F., Lau, R., & Murray, E. (2016). Factors that influence the implementation of e-health: a systematic review of systematic reviews (an update). *Implementation Science*, *11*(1). doi: 10.1186/s13012-016-0510-7

Ruparelia, N. B. (2010). Software development lifecycle models. *ACM SIGSOFT Software Engineering Notes*, *35*(3), 8-13.

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Sage.

Sewell, M. (n.d.). The use of qualitative interviews in evaluation. *The University of Arizona*. https://cals.arizona.edu/sfcs/cyfernet/cyfar/Intervu5.htms

Sköldberg, K. (2009). *Reflexive methodology: new vistas for qualitative research*. Sage.

Sligo, J., Gauld, R., Roberts, V., & Villa, L. (2017). A literature review for large-scale health information system project planning, implementation and evaluation. *International Journal Of Medical Informatics*, *97*, 86-97. doi: 10.1016/j.ijmedinf.2016.09.007

Son, Y., Jeong, S., Kang, B., Kim, S., & Lee, S. (2015). Visualization of e-Health Research Topics and Current Trends Using Social Network Analysis. *Telemedicine And E-Health*, *21*(5), 436-442. doi: 10.1089/tmj.2014.0172

Sosial- og helsedepartementet. (2020). *Telemedicine in Norway. Status and the road ahead.*. Bondevik's 1st Government. Retrieved from https://www.regjeringen.no/en/historical-archive/Bondeviks-1st-Government/andre-dokumenter/hod/1998/telemedicine-in-norway-/id420022/

Stoop, A. P., & Berg, M. (2003). Integrating quantitative and qualitative methods in patient care information system evaluation: guidance for the organizational decision maker. *Methods of information in medicine*, *42*(4), 458-462.

Stuckey, H. L. (2013). Three types of interviews: Qualitative research methods in social health. *Journal of Social Health and Diabetes*, *1*(02), 056

Tapanainen, T., Dao, T., Nguyen, H., Eikebrokk, T., & Moe, C. (2016). Exploring health information technology implementation success factors: a comparative investigation in Nordic countries. *International Journal Of Healthcare Technology And Management*, *15*(4), 326. doi: 10.1504/ijhtm.2016.10005029

Tatnall, A., & Gliding, A. (1999). Actor-network theory in information systems research. In *Encyclopedia of Information Science and Technology*. (pp 955-966)
Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a Qualitative Research Approach. *Journal Of Graduate Medical Education*, *7*(4), 669-670. doi: 10.4300/jgme-d-15-00414.1

Tellis, W. M. (1997). Application of a case study methodology. The qualitative report, 3(3), 1-19.

Walderhaug, S., Granja, C., Horsch, A., & Hartvigsen, G. (2015). *Telemedicine Services in Arctic Environments – Challenges for Successful Implementation*. Lecture, Tromsø.

Walsham, G. (1995). Interpretive case studies in IS research: nature and method. *European Journal of information systems*, *4*(2), 74-81.

Walsham, G. (1997). Actor-network theory and IS research: current status and future prospects. In *Information systems and qualitative research* (pp. 466-480). Springer, Boston, MA.

Walsham, G. (2006). Doing interpretive research. *European journal of information systems*, *15*(3), 320-330.

van Gemert-Pijnen, J., Nijland, N., van Limburg, M., Ossebaard, H., Kelders, S., Eysenbach, G., & Seydel, E. (2011). A Holistic Framework to Improve the Uptake and Impact of eHealth Technologies. *Journal Of Medical Internet Research*, *13*(4), e111. doi: 10.2196/jmir.1672

Van Wyk, B. (2012). Research design and methods Part I. *University of Western Cape*.

Verdinelli, S., & Scagnoli, N. I. (2013). Data display in qualitative research. *International Journal of Qualitative Methods*, *12*(1), 359-381.

Zainal, Z. (2007). Case study as a research method. *Jurnal Kemanusiaan*, *5*(1).

Zayyad, M., & Toycan, M. (2018). Factors affecting sustainable adoption of e-health technology in developing countries: an exploratory survey of Nigerian hospitals from the perspective of healthcare professionals. *Peerj*, *6*, e4436. doi: 10.7717/peerj.4436

Appendix

Interview questions (varied based on role and narrative of the story)

1) What is your name?

2) What are you working on?

3) What system and software are you currently using for your job?

4) How do you experience using the software?

5) Have you used vendor's software?

6) What was it like working in that software?

7) Why do you think this might be your experience?

8) What development approach and tools did you use?

9) How did you develop software?

10) How were you involved in development?

11) Have you been in contact with the vendor before? Direct or indirect?

12) Have you been involved in further development of the software? (if yes) In what form?

13) How did you experience it?

14) How do you think it was (refer to the experience mentioned in answer to question n 9)?

15) What was the result of working with the company?

16) General comments