Innovation as a process

A study of the processes involved in integrating an app with healthcare systems

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Abstract

This thesis investigates the IT innovation processes in healthcare. The case study research follows a startup company that wants to introduce their app as a tool for the clinical workflow in hospitals. The thesis looks into the different aspects of this process, how innovation can be supported, and the challenges involved.

I worked together with Diffia for just over a year and was able to participate in the innovation process with an inside perspective. The case study research is analysed with the pattern matching approach and the empirical pattern matches well with the expected pattern from the research literature.

The findings show that the organizational processes are not set up to support innovation and that resources are not often made available to innovation projects. However, self-contained units that develop lightweight IT solutions can be a good option for the innovation process. The findings also suggest that apps can be beneficial in regards to reducing the complexities and time to complete tasks in the clinical workflow. As it is, the IT innovation process is time-consuming and come with many up-front costs.

Keywords: innovation, healthcare, startup, lightweight IT
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Chapter 1

Introduction

This thesis is a study of the journey undertaken by a startup company to innovate the healthcare industry. Founded by health professionals, the company has tailored their app to the clinical workflow. They also want to integrate their app with existing healthcare systems at hospitals in the South-Eastern Norway regional health authority in Norway. The study is about that IT innovation and integration process. This chapter describes the background of the study and the motivation behind the thesis. It also contains the research questions, some common terminology, and an outline of how the thesis is structured.

1.1 Background

This thesis is a case study of an innovation process. It revolves around technology and how it can be used to improve the clinical workflow in hospitals. The main actors in this case are the startup company Diffia, the regional health authority (RHF) Helse Sør-Øst, and a few of the organizations owned by the RHF. The healthcare industry is not a field known to be very successful at facilitating new IT innovations, despite the efforts and positive attitudes of the people in it.

During the events described in Chapter 4, Diffia developed an app to be used by nurses to register the vitals information from patients. It is meant as a documentation tool that can be carried around in the pocket. The app is also meant to update the patient journal—the electronic health record (EHR)—during the clinical workflow no matter where the nurse is, as long as there is a wireless connection to the EHR system. Thus, the app needs to have some kind of integration with the EHR systems at the hospitals. The aim is to let the app exchange patient data
using FHIR, an industry standard made exactly for that purpose. It will communicate with an adapter service that enables the app to exchange data with any of the IT systems used at the hospital even if those systems do not support or is not compliant with the FHIR standard.

The entirety of this innovation and integration process is one that spans years. The startup was founded in 2013 but it was only in April 2015 that things really began to happen for Diffia. As of the deadline of this thesis (May 1st, 2017) the process was still ongoing, though they have come far, including testing the app together with Sunnaas hospital. I was not able to extend the thesis any further and see the entire innovation process to its completion due to time constraints. This thesis does, however, contain a large portion of the process and the challenges.

The organizations

A detailed overview of the different stakeholders involved in the innovation and integration process can be found in Chapter 4 Section 4.2.

Diffia is a startup company and the perspective of the case is seen with an inside-view from within this organization. I was already working part-time for Diffia when I switched the topic of my thesis to research the IT innovation process they were involved in. The main founders are health professionals with a background in the healthcare industry. November 2016 was the last month I worked at Diffia, though I still hold a tiny minority share in the company as part of the work I did.

Helse Sør-Øst (HSØ) is the South-Eastern Norway regional health authority and governs the hospitals and specialized care in the south-east region of Norway. Akershus University Hospital (Ahus) and Sunnaas Hospital are the two hospitals that Diffia aimed to test and sell their app to.

Sykehuspartner is also a company owned by Helse Sør-Øst and is focused on technology. Sykehuspartner is the organization that manages and maintains the IT system infrastructure at the hospitals in the region. The IT needs and requirements all go through their centralized process and when the hospitals want to acquire a new software system, such as the app by Diffia, the order for it and relevant technical documents have to go through Sykehuspartner.
CHAPTER 1. INTRODUCTION

1.2 Motivation

I was working part-time with Diffia when the current topic for this thesis was selected. The previous topic had revolved around studying the paper-based process nurses do to register patient vitals and compare it with the same process when an app was used. I was also working with Diffia at that time. It became, however, quite apparent that Diffia was not going to be able to integrate the app we were making and test it with nurses in the time-frame I had available to research the thesis. The thesis was refocused on to the innovation and integration process itself instead.

Healthcare is very important to many. But it is not known to be an arena conducive to IT innovation. I would like to be a part of improving this process. The research in this thesis can help shed light on the innovation processes that takes place and the challenges involved. The literature contains many insights into why innovation and healthcare may not be the easiest of companions. There is a pattern that can be pieced together from many different sources and applied to the intersection of IT innovation and the healthcare industry. It is the expected pattern and I have through my case and research found a companion empirical pattern and compared them. I have found things that match and things that do not seem to match as well as the literature state they should. The pattern matching is discussed in great detail in Chapter [6].

I hope that this research will be beneficial and improve the use of technology in healthcare. That it results in better care for the patients and that it improves the clinical workflow for the health professionals who help and save lives.

1.3 Research questions

This section is about the research questions. Technology and healthcare is a very large field to cover. IT innovation and integration processes are a more manageable topic for a thesis. However, there are many stakeholders involved and they are all very busy. These processes currently take a long time and there are many bureaucratic steps involved in large, public organizations. The IT innovation process is not well defined and having a few companies to “blaze the trail” helps to shine a light on the challenges involved.

I already had access to Diffia, and their organizational processes are faster paced than that of the other organizations involved in the innovation process. Thus, I chose to build the case research mainly from an inside perspective of
CHAPTER 1. INTRODUCTION

Diffia. The research and empirical pattern are based on this unusual perspective that very few have the privilege to experience for themselves.

1. How can a startup company that is creating an app for use in the clinical workflow contribute to IT innovation in hospitals?

IT innovation in healthcare is sought after but the industry lags behind others, such as bank and finance. It is an industry that has embraced self-service solutions on both on the web and mobile devices, as well as contactless payment and money transfers with only an app and a phone number. The healthcare industry has access to all of the same technologies yet “nothing has happened in IT in twenty years” (IT manager at Ahus).

I wanted to study the IT innovation process and find out how a startup could create new value in this setting.

2. How can an app improve the clinical workflow for health professionals?

The healthcare industry has a history of introducing IT systems that require the health professionals to adapt their existing workflows around them. Much of this can be attributed to the way many of them can only be used from a stationary terminal and not used from a device they carry with them.

I wanted to study how the app approach affected the clinical workflow and if the app format could be sufficiently tailored to it rather than the other way around.

3. How can an app interface and exchange patient data with existing IT systems in the hospitals?

Data exchange and interoperability is an important part of building a robust IT ecosystem that can support new software. The healthcare industry has a history, however, with silo mentality and systems that can be challenging to integrate with. I wanted to study how the app would overcome these challenges and integrate with the existing hospital IT infrastructure in hospitals.

1.4 Common terminology

Electronic Health Record (EHR) The electronic collection of patient data. There are a few alternatives–electronic medical record, electronic patient record–and they have small differences in meaning in the healthcare industry. For
simplicity, this thesis uses the EHR term in all places unless otherwise stated.

**EHR system** The system that holds all of the patient data. The term used in this thesis use the extended meaning whereby the EHR system is also to mean that the system includes administrative features and not just pure patient data.

**Health professional** A term used to group workers in healthcare. Can include doctors, nurses, clinicians, physicians, and other occupations involved with patient care. This thesis use the term health professionals in most cases to simplify the domain, but uses the specific occupations where it is relevant or where distinctions are necessary.

**Hospital Trust** A formal organization structure under the Regional Health Authority. Unless otherwise stated this is used to refer to Hospital organizations.

**Innovation** There are many forms of innovation but in this thesis, unless otherwise stated, innovation is used to refer to innovation through technology. For example, it can be innovation in healthcare by introducing a new app tailored for the clinical workflow, or introducing a platform that facilitates integration with existing IT systems in the healthcare sphere.

**Regional Health Authority (RHF)** The regional governing body for healthcare in Norway. Helse Sør-Øst is one example, and these large organizations own and manage the hospitals in their region, such as Akershus University Hospital (Ahus) and Sunnaas Hospital. Helse Sør-Øst also own Sykehuspartner, which is not a hospital but instead manage the IT systems for the South-Eastern Norway regional health authority.

### 1.5 Outline of the thesis

This section present the chapters together with a short description of what each of them contain. The list also contains this chapter for the sake of completeness.

*Chapter 1: Introduction* introduces the background for the thesis and presents the research questions. It also contains a section with common terminology
used in this thesis and clarifies the usage of some of them that can have a
broad or conflicting meaning in everyday use.

**Chapter 2: Theory** contains the main literature from the field of large, often
public, organizations, innovation, and healthcare. This chapter also presents
the expected pattern used for the analysis in Chapter 6.

**Chapter 3: Methods** present the research methods and the validity of the ap-
proach taken.

**Chapter 4: Case** presents the innovation process case featuring the startup com-
pany Diffia and Helse Sør-Øst, the South-Eastern Norway regional health
authority. A timeline of relevant events is included, as well as a section of
the main stakeholders involved in the process.

**Chapter 5: Findings** presents the data collected and the empirical pattern.

**Chapter 6: Discussion** contains the analytical generalization. It is based on the
pattern matching of the expected pattern and the empirical pattern. The
patterns can be found in Chapter 2 and Chapter 5 respectively.

**Chapter 7: Conclusion** contains the summary of the thesis and a note on future
work.
Chapter 2

Theory

This chapter explores the literature and related work. The expected pattern is based on the literature and comes after.

2.1 Literature and related work

This section goes over the literature and related work. Some of the literature presented in this chapter is based on the innovation process while some of it is directly related to the healthcare industry. There are studies that focus on the adoption of apps in clinical the workflow and how the integration of new EHR systems is received by health professionals, as well as looking into the technical challenges involved. Industry standards are touched upon, as well as the divide between lightweight and heavyweight IT systems in healthcare, and how some systems are managed with a silo mentality.

Direct patient care

Good routines are important in the healthcare industry. Organizational and individual factors influence good patient care. Rosta and Aasland [2016] did a study on the time doctors spend on direct patient care, and approximately 1600 doctors in Norway participated in their study. Their sample of participants spanned a twenty year period, from 1994 to 2014. During this period working hours among doctors remained largely unchanged. Hospital doctors, among the forty-five disciplines in Norway, were the group that had the biggest reduction in time spent on direct patient care. Most of the reduction was between 2000 and 2014. In comparison, general practitioners only had marginal changes in the amount of time spent
on direct patient care. Some of the reduction can be attributed to demographic changes.

There has been a greater increase, percentage-wise, in hospital doctors than that of potential patients. Despite that, productivity among health professionals in Norway has fallen during the period. One reason might be because the doctors have taken over a lot of the documentation tasks that was previously done by medical secretaries. The doctors report that these tasks are at the expense of their treatment of patients. Another factor might be the active role given to nurses regarding patient diagnosis and treatment.

**Tailored clinical workflow**

The rise of IT in the clinical setting has caused some researchers to question how well health IT reduces diagnostic errors. El-Kareh, Hasan, and Schiff [2013] has reviewed the literature to find out. Published in 2013, the review found few studies evaluating the interventions in actual clinical settings and even fewer demonstrating clinical impact. Some studies did demonstrate better time efficiency for processes and one had data that suggested computer systems can help find information the health professional missed. The authors found that study to be underdeveloped. In addition, they also found other studies that had found that simply providing access and time to review a medical textbook can support a diagnostician by avoiding exclusive reliance on memory.

The results show that the progress in diagnostic health IT has been slow and incremental, and that there are areas that can be improved. The first is to integrate electronic measurement of the accuracy of the diagnostic process directly into the clinical workflow. The second is to improve and expand collaboration with cognitive science and human-computer interaction experts in order to improve the structure and interfaces of Electronic Health Records (EHR). The third is the need to integrate evidence-based diagnostic investigations into computerized order entry systems in a way that is flexible for the clinicians while avoiding over-alerting. The fourth and final area is to enhance and better the support for systematic feedback of the diagnostic performance, so that clinicians can improve their diagnosis.

In short, the authors propose that diagnostics can be improved if the IT systems were better tailored for the clinical workflow, as well as adding a feedback loop so that health professionals can improve their diagnosis.

Getting critical patient information to health professionals is important (Bis-
bal, Grimson, Grimson, Berry, and Hederman, 2003). Information technology (IT) is often the means by which crucial data can be distributed to the health professionals. However, according to Lium, Tjora, and Faxvaag, 2008, the cost-benefit of not having to maintain a paper archive is not enough. In their article “No paper, but the same routines,” they conclude that the real issue with EHR systems is that the paper-based routines and structures still prevails. The authors based their study on 18 semi-structured interviews with physicians in two Norwegian hospitals in the later parts of 2000. They further believe that the explicit goal of going paperless should be to streamline processes and improve quality. That to overcome the paper legacy that is slowing down the pace of organizational changes, new routines need to be established.

A study by Ellingsen and Monteiro, 2017 supports the idea that the IT systems should be tailored to the clinical workflow. Based on an integration effort, the study was conducted at a Norwegian hospital between 2004 and 2005. The one-size-fits-all model is used for many IT systems in the healthcare sector, but the study finds that it hurts the clinical workflow. Instead of making health professionals more efficient and productive, the system starts to dictate the workflow and limit their actions. The study states that such systems result in a situation where the workers need to invent additional, often time-consuming workaround routines.

**Innovation and bureaucracy**

A study by Thompson, 1965 suggests that innovative organizations are costly, at least on the surface. The paper states that innovation is “new ideas, processes, products or services”, while bureaucracy, on the other hand, is inappropriate for creativity. Instead, it is a driver for productivity and control by management. Innovative behavior is seen as unreliable and the conflict creativity thrives on is not legitimized. The author states that large government organizations feel the need to increase innovation. There is a conflict then, between the management heavy organizations and their capacity for innovation. The bureaucratic organizations need innovative areas, including a decentralized control of resources. This should be done to such a degree, the author states, that everyone can (or should) take part in the innovation process. These requirements were a big part of why the author suggests that truly innovative organizations are costly.

Innovation in large organizations seems to be very challenging. In a study by Dougherty and Hardy, 1996, it is found that stable, long-running organizations
find innovation difficult. Yet they must support sustained product innovation in order to stay competitive. The study also makes a distinction between challenges linked to specific projects and those linked to the organizational context, with the latter being the focus of the study.

Key areas to improve for sustained innovation are resource availability, collaborative structures for creative problem-solving, and innovation as part of the existing business strategy. Ideally, the authors state, organizations should have a resource system that is able to support all of these areas at the same time. It is mentioned, however, that when the normal practice is focused on established activities then innovation is less likely to be allocated resources. One solution suggested to help, would be to make seed money available for potential innovation projects on all levels of the organization.

The study found, unfortunately, that organization-wide collaboration and problem-solving are not often supported by the processes in mature organizations. Instead, existing business practices are given a place of privilege in the overall strategy. Creativity and new products are found to not be favored in large, mature organizations. The authors propose that the configuration of power should shift to an organizational system base in order to sustain innovation. That the “conceptualization of power must extend beyond the personal and encompass the organizational”.

In “Sustained Product Innovation in Large, Mature Organizations,” the same paper by Dougherty and Hardy, 1996, successful innovation projects are linked to individuals. These champions would use their position and personal network to bargain with others in the organization and push their projects through. The authors state that successful innovation had to be created in separate units, though these units would often only have piecemeal access to necessary resources. Neither was these critical resources always provided for effective problem-solving. When available resources did exist it was not deliberately earmarked for innovation, but something that resourceful individuals could get to through their personal networks.

The study also found that innovation was unseen by the people not directly involved. They were unsure what they could do to help, or even if they should help or not. As such, innovation was invisible in the wider organization context with a community that could not understand its role.

The authors propose a short-term solution where organizations empower champions of innovation. By separating innovation processes into self-contained units they become easier to support. The organization can train newcomers as well as retain those with networks and expertise. Facilitating both mentorship and the
sharing of personal networks. The authors caution that sustained innovation over time, on the other hand, requires innovation to be seamlessly incorporated into the entire organization.

**Silo mentality and internal politics**

Many health IT systems are designed as silos, as exemplified in the study “Innovation in healthcare delivery systems: a conceptual framework” by Omachonu and Einspruch, 2010. “In some cases, a patient’s chart in one hospital cannot be read by another hospital”. The study states that such IT systems are often designed with their own rules and formats. That they inhibit the opportunity for information sharing. Silo systems are also often difficult to integrate with and tend to scale poorly (Bygstad, 2016). However, there are efforts to integrate these silos. Bygstad, 2016 mentions cloud computing and service-oriented architecture as examples.

Bannister, 2001 writes about the challenges with silo systems and how it is affected by public administration. In his paper “Dismantling the silos,” he describes the heart of the problem to be a combination of unintegrated, often legacy systems, which are often made in isolation from the rest of the organization. New technology and the way technology is thought about is needed, but the “bastion of bureaucracy” that is public administration, he claims, is also very resistant to change. Civil service is mostly focused on cost saving and productivity parts of IT, and measures used in the competitive private sector often have little meaning.

Some of the issues stem from politics. The IT systems are at times developed with short-term political gain as valued by the politicians currently in power. The author also states that there is generally little in the way of communality in public administration. The majority of IT systems are unique and custom built, and may become obsolete or redundant due to changes in politics or organizational changes. He adds that this silo structure is not efficient and that huge amounts of latent value are inaccessible from it.

Another issue Bannister, 2001 mentions is IT managers with no real power among the leadership in the organization. Often the highest IT position in public administration is the equivalent of the upper parts of middle management. As such, it can be challenging to resist politics favoring short-term solutions instead of being able to foster long-term IT strategies.

A possible solution suggested by Bannister, 2001 is to change the value by which IT systems are measured. More informed decisions can be made on the
basis of a cost-benefit balance tied to the quality of service as benefited by the citizens. The author proposes this wider perspective that embraces the people affected by the “mechanistic measurements of IT effectiveness”.

Omachonu and Einspruch, [2010] believe it should be possible for patient information to follow the patient, though conflicts between systems can make data exchange impossible. Innovation in health IT is put forth as the most likely option that could improve health care quality and cost containment. Unfortunately, the authors also refer to it as a process that can promote a culture of blame. With individual autonomy and reputation being favored by the health professionals.

The authors believe that there is a lack of information about the actual process regarding innovation in the healthcare industry. They state that the needs of the health professionals, as well as those of the patients, are at the very core of the process. It is not surprising, then, that innovation in healthcare is often initiated by the stakeholders from the field, including health professionals and patients. The study also finds that the government is behind some of the changes, and might force such changes upon the health authorities.

**Lightweight IT and heavyweight IT**

This thesis draws upon research by Bygstad, [2016] to differentiate between the type of software systems used in healthcare. The concepts are *lightweight IT* and *heavyweight IT*. Though the paper states that the concepts are ideal types and that the line is not always clearly defined. Systems can also move from one side to the other during its lifetime.

Lightweight IT is often based on apps on smartphones and tablets. Based on a culture of innovation and experimentation, users usually initiate its creation process with IT product specialists. The typical use case for lightweight IT is apps that support a specific workflow or provide simple pieces of information. The most common issues come from integration, where apps can easily become isolated and unusable. Security and privacy are other issues, particularly regarding healthcare.

Heavyweight IT, on the other hand, is the mainstream IT. It uses proven technologies and is typically the back-office systems, such as the Electronic Health Record (EHR) or Customer Relationship Management (CRM) systems. Designed by system architects, it integrates servers and databases with a culture focused on quality control. Heavyweight IT is not issue-free either. The installation and training process usually follows a waterfall model and the use is often mandatory.
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Lightweight and heavyweight IT can co-exist, and often do so very well. Bygstad, 2016 states that heavyweight IT provides a platform and a repository of data that lightweight IT depends upon. Innovation processes can then be pushed by the latter and support the overall system ecology. The study shows that scaling can be easier with heavyweight IT, though a clear exception is silo systems. Another issue is that integration between the two types of IT is costly and brings with it a lot of complexity. The study found that one of the projects they studied would in all likelihood have failed if they had started with integration. It would also have needed larger funds up front to tackle the added complexity. Innovation is best served, Bygstad, 2016 states, outside large organizations. Smaller organizations can offer lightweight IT solutions built on top of heavyweight IT platforms designed to facilitate for innovation.

Mobile devices

Apps and smartphone use are one area of health IT systems that is not directly tied to the traditional workstation mentality. Koehler, Vujovic, and McMenamin, 2013 have found that mobile phones are in common use at hospitals and their results suggest that the use will increase in the future. The study is from Australia and was published in 2013.

In the study, the health professionals often use their own privately owned device at their workplace when using medical apps. It was also unclear to many of them if their employer really allowed the use of such apps or not. Some of the reservations the participants had were about cross-infection and potential patient confidentiality breach. They were also worried that using medical apps in front of patients might appear unprofessional. The study suggests that smartphones should be treated and cleaned with similar disinfectant as other medical equipment. Software that can remotely delete data in the event the smartphone get stolen or lost is also suggested. In the study, health professionals had a positive attitude to the use of smartphones and their use in the clinical workflow. The same, and a little more, for the use of the Internet. In general, they preferred to use technology to locate information compared to the use of textbooks. The authors conclude that smartphone use in the clinical workflow may become a key resource, though that it still require further research. One thing to note about this study is that the apps mentioned were mostly medical calculators. The apps were not integrated with any EHR system or licensed by the hospitals.

Apps and smartphones are also a major part of lightweight IT, and a paper by
Steinhubl, Muse, and Topol, 2013 seeks to answer if mobile health technologies can transform healthcare. The authors believe that mobile health IT “have the potential to change every aspect of the healthcare environment”. The result will be less costly and patients will be actively engaged in their own care. They believe that a potential roadmap for implementation is needed to get the most out of this mobile health IT. One that confirms these benefits to the patients and health professionals, as well as the decision-makers and those who ultimately end up paying for it. The study finds the complexities of the health care system to be the major obstacle. Another issue is the flood of healthcare-related apps on the market that has little to no oversight or review by professionals.

There are some challenges, however, with developing for mobile devices. Joorabchi, Mesbah, and Kruchten, 2013 outlines some of them in their paper “Real Challenges in Mobile App Development.” It has mostly to do with the differences in device operating system (OS) and approaches to app development. Apps developed natively for one OS can not be run on different OS. Their results show that dealing with multiple such platforms is one of the biggest challenges. There are other approaches, however, that can mitigate this issue, and they both utilize web technologies. One approach is to build websites designed to be run on mobile devices in the browser of the smartphone. The other is called a hybrid app, and the approach is to wrap the website in an app container on the smartphone and run it locally as if it were a native app.

Some issues are related specifically to the mobile devices in healthcare. The paper “A secure mobile healthcare system using trust-based multicast scheme” by Boukerche and Ren, 2009 take a closer look at what some of these issues might be. They state that studies on wireless security show that there is a need for special strategies for network security. Medical information needs to be kept confidential and their research finds that patients only want health professionals to have access to their records. The key areas are: safe patient information exchange, preventing illegal devices that can intercept data, and proper authentication. The authors do, however, highlight mobile healthcare as a means to boost diagnosis and patient care by providing access to patient information “at any place and at any time”.

Interoperability and data exchange

Interoperability is the next big thing needed to take advantage of lightweight and heavyweight IT. A paper by Bender and Sartipi, 2013 states that healthcare systems need interoperability to succeed. A paper by Lamprinakos et al., 2014 agrees
with the sentiment and adds that it is also a key factor for successful clinical workflows. The first paper also states that standards are a big part of interoperability, and that it increases public safety. Both papers lament the lack of a single, complete standard for patient information exchange. HL7 provides several such standards, and both papers highlight the HL7 FHIR standard as the best choice. Research by Bender and Sartipi, 2013 show that the standard is a popular choice, and research by Lamprinakos et al., 2014 shows that all of the HL7 standards are in wide use. Though the latter adds that the FHIR standard takes full advantage of the positive aspects of its predecessors, the HL7 v2 and HL7 v3 standards.

FHIR stands for “Fast Healthcare Interoperability Resources” (Lamprinakos et al., 2014), and is developed and maintained by HL7, an international community (non-profit) of experts in the health IT field (Bender and Sartipi, 2013). The standard is based upon existing technologies in wide use, like the RESTful architecture and the HTTP protocol. Bender and Sartipi, 2013 further states that FHIR provides an easily consumable API well suited for lightweight interfaces, such as smartphones and tablets. The paper by Lamprinakos et al., 2014 echoes the sentiment about being suitable for mobile environments. It also states that integration of healthcare systems can be easily done with the FHIR standard. Bygstad, 2016 on the other hand, states that too much focus on standardization might not be a good thing. The healthcare sector is complex and his research suggests that waiting for a complete standard will stifle innovation. He points out that standards are not unnecessary, but that they are the means and not the aim.

Interoperability is enabled by standard protocols. In his paper “Middleware,” Bernstein, 1996 defines interoperability as a means where “a program on one system can access programs and data on another system”. It is only possible if the systems can understand each other by using the same protocol. One might experience issues with interoperability when different vendors use different standards and interfaces, or concerning legacy systems where the interface is no longer supported by the industry. The author proposes middleware services as a possible solution. Such a solution sits between different applications, should support a standard API (Application Programming Interface), and can interface with other systems using their own specific API.

Such a solution is a great benefit for application developers. The paper states that it saves resources on maintenance, which allows the developers to focus more on functionality. A possible concern when using middleware is the risk that it will become outdated. The author also adds that the middleware should implement a transparent API to make it more easily accepted by the market. Mobile comput-
ing and multimedia are areas the paper mentions that will be a strong driver for middleware services, though the paper was published in 1996 before smartphones were in common use.

**Electronic Health Record**

In this thesis, the heavyweight IT is almost always the electronic health record (EHR) system. It is the goal of all of this interoperability discussions and Tang and McDonald, [2006] has written about the subject in-depth. They begin by defining an electronic health (EHR) record as a “repository of electronically maintained information about an individual’s lifetime health status and health care, stored such that it can serve the multiple legitimate users of the record”. A paper-based record has practical and logistical limitations that an EHR is designed to overcome. There are additional benefits as well.

The authors mention that the use of EHR is both flexible and adaptable. It can store multimedia data such as echocardiographic videos and help the health professionals by supporting validation of inputs. An EHR is accessible to anyone who has the proper authorizations and can be accessed from any location with an Internet connection, be it at work or from home. The EHR systems are also useful in that they also provide information management tools for the patient data. Communication-capabilities are also highlighted by the authors as a benefit of this extended functionality of the EHR system. Routine hand-offs at the end of the shift are made easier and decision support is available at the point-of-care.

There are some disadvantages to electronic health records and the systems that manage them. Tang and McDonald, [2006] mentions a large initial investment as a barrier to EHR systems. The systems also take a while to learn and the health professionals will have to be trained in their use. In order to use the system efficiently, the authors state that the health professionals will need to redesign of their workflows. Part of this redesign relates to data-entry. It can be a time-consuming process because health professionals “must interpret or translate the data, as well as enter them into the computer” (Tang and McDonald, [2006]). Additionally, these manual data-manipulations may result in transcription errors, and the authors are advising vigorous validity checks. Another risk in the technological realm is the possibility of a catastrophic failure. Thus, some processes must be designed in the event that patient data is unavailable.
2.2 Expected pattern

The expected pattern is based on the literature and can be found in Table 2.1. It, and the outcomes in it, form the foundation of the case study research and the analytical pattern matching in Chapter 6: Discussion.

<table>
<thead>
<tr>
<th>#</th>
<th>Expected pattern outcome</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Resources are not deliberately designated for innovation and innovators often only get limited or piecemeal access to those necessary resources</td>
</tr>
<tr>
<td>2</td>
<td>Structures and processes in large, mature organizations sustain routine work and favor existing businesses over innovation</td>
</tr>
<tr>
<td>3</td>
<td>IT managers in public organizations are often unable to influence the overall IT strategy</td>
</tr>
<tr>
<td>4</td>
<td>Workers not directly involved with innovation often do not know what to do to help or that they could help out</td>
</tr>
<tr>
<td>5</td>
<td>Successful innovation happens in self-contained units</td>
</tr>
<tr>
<td>6</td>
<td>Successful innovation is closely linked to the efforts of individuals who use their position and network to gain access and resources</td>
</tr>
<tr>
<td>7</td>
<td>Patient data is managed with a silo mentality</td>
</tr>
<tr>
<td>8</td>
<td>IT systems in the healthcare industry fit so badly with the clinical workflow that health professionals often end up inventing time-consuming work-around routines to deal with them</td>
</tr>
<tr>
<td>9</td>
<td>Health professionals have largely positive attitudes towards the use of smartphones as part of the clinical workflow and the possibility of greater reliance on them in the future</td>
</tr>
</tbody>
</table>

Table 2.1: The expected pattern

Expected pattern outcome 1

The expected pattern outcome 1, *Resources are not deliberately designated for innovation and innovators often only get limited or piecemeal access to those necessary resources,* in Table 2.1 concerns the availability of resources new projects have when they try to affect change in an organization. Integration carries with it a
large up-front cost (Bygstad, 2016) and the resources necessary to effectively succeed in a reasonable time-frame is rarely available (Dougherty and Hardy, 1996).

Dougherty and Hardy, 1996 found that innovation projects were not often given access to resources they would need to successfully innovate. Many such innovation projects would simply fail before they had been able to provide the organization with any meaningful change. The authors also found that in the instances when the innovation project did get access to resources it was only available in piecemeal. These resources were not earmarked for innovation directly, but the innovation project was in some instances able to claim some of it over time. One of the major factors the authors found to influence resource availability is the business practice processes. Those organizations that favor existing business practices often does so at the direct cost of innovation.

Expected pattern outcome 2

Resource availability is largely related to the expected pattern outcome 2, Structures and processes in large, mature organizations sustain routine work and favor existing businesses over innovation, which concerns the internal structures and processes of large organizations. New ideas are stomped down on in favor of the tried and true processes already known from existing businesses (Dougherty and Hardy, 1996). One reason is that innovation thrives best in situations with conflict and where creativity is legitimised and encouraged (Thompson, 1965). Some of this perspective in public management can be linked to archaic methods by which IT systems are measured. Often they are measured on purely monetary grounds—like the return on investment—and not on the quality of service it provides for its users (Bannister, 2001).

Expected pattern outcome 3

The expected pattern outcome 3, IT managers in public organizations are often unable to influence the overall IT strategy, concerns IT strategy and the ability to influence it. IT managers in public organizations are often unable to influence the overall IT strategy due to their position within the hierarchical management. Their position in public organizations is often only equivalent to that of upper middle management (Bannister, 2001).
CHAPTER 2. THEORY

Expected pattern outcome 4

IT managers are not the only ones who lack influence, however. The expected pattern outcome 4, *Workers not directly involved with innovation often do not know what to do to help or that they could help out*, concerns the workers that are not directly involved with new product creation and innovation. The people that are not involved with innovation processes do not know how to help (Dougherty and Hardy, 1996). They do not necessarily ignore the innovation process by design but because it is often an unseen part of the organization (Dougherty and Hardy, 1996).

Expected pattern outcome 5

This can be linked to the expected pattern outcome 5, *Successful innovation happens in self-contained units*, which concerns where innovation takes place. Short-term solutions for successful innovation involves separating those processes into self-contained units (Dougherty and Hardy, 1996). Separating the organizations that do innovation and those that offer a platform is the best way to serve the innovation process (Bygstad, 2016). There is, however, a risk that such a separation causes the systems to evolve in isolation and become legacies that are costly to maintain (Bannister, 2001).

Expected pattern outcome 6

The expected pattern outcome 6, *Successful innovation is closely linked to the efforts of individuals who use their position and network to gain access and resources*, concerns those who manage to innovate successfully. They are often those who are able to leverage their position and personal network to drag their innovation project through organizational process that does not really support it (Dougherty and Hardy, 1996). And even then the project may be halted or canceled once control is transferred over to management (Dougherty and Hardy, 1996).

Expected pattern outcome 7

The expected pattern outcome 7, *Patient data is managed with a silo mentality*, concerns how patient data is handled by Electronic Health Record (EHR) systems. The silo mentality is when you have large systems that often hold similar data but is unable to exchange that information with each other or other services.
(Bannister, 2001). It is, for example, when a patient record in one hospital cannot be accessed or read by another (Omachonu and Einspruch, 2010). Silo systems are inefficient (Bannister, 2001) and tend to scale poorly, but integration can be made to create seamless solutions (Bygstad, 2016).

**Expected pattern outcome 8**

This approach to EHR systems affects the clinical workflow, as illustrated in the expected pattern outcome 8, *IT systems in the healthcare industry fit so badly with the clinical workflow that health professionals often end up inventing time-consuming work-around routines to deal with them.* The system must match and support the specifics of the work routines in order to have a chance at being successful (Ellingsen and Monteiro, 2017). A one-size-fits-all model limits the health professionals ability to deliver effective care, and may force them to perform redundant activities (Ellingsen and Monteiro, 2017). The introduction of heavy-weight IT systems did not change the routines or streamline the processes (Lium et al., 2008).

**Expected pattern outcome 9**

Health professionals can be positive about technology as well. The expected pattern outcome 9, *Health professionals have largely positive attitudes towards the use of smartphones as part of the clinical workflow and the possibility of greater reliance on them in the future,* concerns the attitudes they have to the use of smartphones and apps as part of the clinical workflow. Smartphones are in common use by health professionals and attitudes are largely positive (Koehler et al., 2013). It is believed that its use will increase in the future, though the vast majority of apps currently in use are medical calculators and the like (Koehler et al., 2013).
Chapter 3

Methods

This chapter describes the methods used in the research. I worked part-time for a startup company that was developing an app to be used to improve the clinical workflow in hospitals. The processes involved were related to technological innovation and integration with existing hospital IT infrastructure and systems, such as those for the electronic health records (EHR). The research in this thesis is based on those processes.

3.1 Context

The study undertaken as part of this thesis follows a process that intersect information systems and healthcare by way of innovation. The case study research followed a startup I worked with, both as a part-time developer and as a researcher. I have taken part in the processes they went through in order to attempt to innovate the clinical workflow. The product they wanted to develop and introduce to the healthcare industry was an app called Nimble that nurses can use to register patient vitals information. An important requirement for this app was integration with the electronic health record (EHR) systems that the hospitals use. This was so the app reduced the need to return to a stationary terminal every so often, in addition to feature a streamlined way to present only the relevant questions.

Information systems can be any system that accepts inputs and can output data, with the optional step of processing the input. Humans, then can be seen as a information system. However, the concept is usually used to describe digital systems, such as computer applications running on personal computers, servers, and mobile devices.
CHAPTER 3. METHODS

The use of apps can be found in many areas, including healthcare (Koehler et al., 2013). Their use and importance as part of the clinical workflow is thought to be increasing, though currently it is mostly as stand-alone medical calculators without EHR integration (Koehler et al., 2013). An EHR system, on the other hand, is an information system that serves as a repository for digital stores of patient data (Tang and McDonald, 2006). It includes management tools and multimedia capabilities not possible with paper-archives (Tang and McDonald, 2006). The healthcare is the field that encompasses health professionals, patients (and their dependents), and medical practices.

Innovation is the introduction of something new, be it ideas, processes, products, or services (Thompson, 1965). It can be challenging for large organizations to innovate (Dougherty and Hardy, 1996), though apps are better suited for innovation projects than big EHR systems (Bygstad, 2016).

Research paradigm

This study is of a process that intersects technology, healthcare, and innovation, and is part the positivist paradigm. There are three recognised research paradigms: positivist, interpretive, and critical. The first paradigm is concerned with the objective reality. It consists of facts that can be measured and other researchers can validate based on those properties. Positivist studies often set out to test an hypothesis or a theory. The second paradigm is concerned with the socially constructed reality. Experiences and ideas are shared and interpretive studies in informatics often try to understand information systems in a context. The third paradigm is concerned with liberation through social critique. Critical studies in informatics often try to solve problems or challenges together with the community (with Participatory Design a commonly used technique).

I chose to base my study in the positivist paradigm because of the focus on an objective reality. The research details an innovation process and concerns itself with how IT integration can be done in healthcare. There are factual events that can be traced. The process contains certain steps that, though particular to this case, this startup, and these hospitals, are a part of an objective reality. It is not a look into a system from the outlook of different contexts. Neither is the study a social critique. The problems and challenges the process faces are those of integration and not that of social injustice.
CHAPTER 3. METHODS

Qualitative and quantitative research

The study is qualitative as the research is based on qualitative evidence.

There are two forms of evidence. Qualitative research is based on interviews, observations. Quantitative research is based on statistics and data that can be counted and measured. Some research methods can use a mix of qualitative and quantitative data, such as case study research (Yin, 2013, Kindle Locations 1027-1028).

I chose to do qualitative research because that was the nature of the techniques I found to be the most practical for my study. The evidence in the study was in-depth and based heavily on observations and unstructured interviews made as the innovation process unfolded.

3.2 Research method

This thesis is based on the case study research method.

A case study favours how and why questions (Yin, 2013, Kindle Locations 834-835) and is used to investigate a contemporary phenomena in its real-world context (Yin, 2013, Kindle Locations 646-647; Kindle Location 3480). The phenomena that is to be observed can extend into the past, but not so far that no-one is alive to be interviewed (Yin, 2013, Kindle Locations 1167-1169). It is typically about complex behaviour in a complex context from the real-world (Yin, 2013, Kindle Location 3480).

Case studies are “generalizable to theoretical propositions and not to populations or universes” (Yin, 2013, Kindle Locations 1071-1072). They are also empirical inquiries (Yin, 2013, Kindle Locations 958-959) that mostly investigate human affairs or actions (Yin, 2013, Kindle Locations 3014-3015), and since the method is in-depth it often requires the researcher to do fieldwork (Yin, 2013, Kindle Locations 1165-1166). Examples of fields of interest suited for case studies include small group behaviour and organizational and managerial processes (Yin, 2013, Kindle Locations 691-694).

I chose to do case study research because the innovation and integration process I was to study was a contemporary phenomena. I wanted to study how this process would enfold. The field is well suited for a case study approach, both in terms of the group behaviour relating to how the startup should solve the integration challenges, but also in terms of the organizational aspects involved on the
healthcare side. I was already working for Diffia when I switched my topic to the current one and so I was in a privileged position to engage in fieldwork.

The case study is detailed in Chapter 4 and describes the relevant stakeholders and present the events unfolding chronologically as a narrative. The latter is a common approach (Yin, 2013, Kindle Locations 4586-4587) and is one of the major strength of case study research (Yin, 2013, Kindle Locations 3907-3908).

### 3.3 Data collection

I did most of my data collection activities during my fieldwork with Diffia.

One of the major tasks involved in collecting data is to gain access to key organizations (Yin, 2013, Kindle Locations 2509-2511). It is the responsibility of the researcher to make the special arrangements necessary to become an observer or participant observer (Yin, 2013, Kindle Location 2505). It is also important for the researcher to have enough resources, including a computer, a place to work, and motivation (Yin, 2013, Kindle Locations 2511-2516). Another important aspect to be aware of is that it is the behaviour of the researcher and not the field participants that will be constrained (Yin, 2013, Kindle Location 2506).

I chose to do my fieldwork and main data gathering activities with Diffia because they are one of the key organizations involved in the innovation process. I also had unique access to them since I was working for them as a part-time developer.

The fieldwork I did consisted of several types of evidence. Mainly it was passive and participant observation, unstructured interviews, and documents. This fits well with the case study inquiry model. One of its unique strengths is how well it deals with different types of evidence, such as observations, interviews, documents, and artifacts (Yin, 2013, Kindle Locations 866-867; Kindle Locations 3147-3148).

**Observations**

There are different ways to observe, ranging from passive to participant, from formal to informal (Yin, 2013, Kindle Locations 3027-3028). Formal observation activities include meetings, workflow, classrooms, and the like (Yin, 2013, Kindle Location 3030). Insights into the culture of an organization, the condition of the work space, or the status of an employee within the organization can be
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ascertained from the immediate environment (Yin, 2013, Kindle Locations 3032-3034).

Observations are particularly useful in gaining additional insights into the inquiry being made (Yin, 2013, Kindle Locations 3050-3051). As such the technique is well suited to both large organizations or small groups (Yin, 2013, Kindle Locations 3081-3082), though many such groups are often inaccessible and access not lightly given (Yin, 2013, Kindle Locations 3094-3095). One of the distinctive advantages when access is granted is the opportunity to experience the events as of someone on the inside, and not just from an external viewpoint (Yin, 2013, Kindle Locations 3096-3097).

Other advantages include being able to influence minor events, and can only be done as a participant observer (Yin, 2013, Kindle Locations 3098-3100). A downside to this is that it can take a lot of time and effort, which may lead the observer to lack the time to inquire about events from multiple viewpoints (Yin, 2013, Kindle Locations 3105-3106).

I was able to take part in the normal, every day routines of Diffia, a startup with only a small group of people attached to it. As such I took part in much of the everyday events that occurred. I went to meetings, conferences, workshops, and took part in discussions. As a developer on their team I had the ability to influence decisions about relating to the technology that was in use. The choice to use observation as a major source of evidence for the case study inquiry was a natural extension of the access I already had at the time. The observations was for the most part participatory, for some events and activities I was passive. I took part but in a listening capacity and let them unfold without trying to influence the situations. The activities where only Diffia was present was the most informal observations while the meetings with people representing group or department in a hospital more formal.

Interviews

Interviews are a common part of repertoire in a case study inquiry and is one of the most important sources of evidence (Yin, 2013, Kindle Location 2942). The interview form for this type of inquiry is often referred to as an unstructured interview, and will often take the form of a guided conversation (Yin, 2013, Kindle Locations 2942-2943). The researcher still need to satisfy the lines of inquiry while also being friendly and non-threatening in a way that leaves the interviewee to answer openly (Yin, 2013, Kindle Locations 2943-2954).
Interviews are important due to the human factor in most case study research (Yin, 2013, Kindle Locations 3014-3015). However, some interviewees participate so often or to such a degree that their role becomes more of an informant than a mere participant (Yin, 2013, Kindle Locations 2965-2966).

The interviews I undertook during the fieldwork was mainly unstructured interviews and resembled for the most part conversations. Many of the people attached to Diffia became in some aspects informants, though in others they remained participating interviewees. There was not always a lot of time available between the work and activities at Diffia and so being able to have a "five minute" talk every so often was a practice that suited the situation the best. Most of the talks was, of course, longer than five minutes, but it was important to be flexible with the interviewees time. The close proximity also meant that getting an answer to something was as easy as asking the person sitting at a desk close to you, an activity often taking less than the five minutes. This ability to inquire at the times when the participants had time without having to specifically book meetings with them was very beneficial to the case study research.

Documents

I have been privy to several different documents that have been necessary in the process of integrating an app with existing electronic health record (EHR) systems. This includes agreements, technical documentation, email correspondence, and minutes from meetings.

Diffia has signed several agreements with different health authorities and support organisations. There are many agreements involved with a collaboration project involving an integration process. Some of them include formal agreements for collaboration, Data Processing Agreements, and the like. There was also an incident where unclear agreement requirements resulted in a small setback that completely halted progress for a short while.

Some of the documents were about technology, including ones describing interfaces, integration, message buses, implementation, and the use of identification tokens for different hospitals. Other documents contained minutes from meetings and slides from presentations. Emails and written communication through other digital means was a useful resource for events I could not personally attend or had happened in the past.
3.4 Analysis

One of the best fitting analytical approaches in case study inquiries are pattern matching (Yin, 2013, Kindle Locations 3655-3656). This involves comparing an expected pattern based on the literature with the empirical pattern based on the findings (Yin, 2013, Kindle Locations 3656-3658). If the comparison of the expected and empirical pattern show a strong similarity then the internal validity is judged to be strong (Yin, 2013, Kindle Locations 3659-3660). Two approaches to pattern matching exist—predicting a pattern based on rival independent variables or predicting a pattern of nonequivalent dependent variables–however, the basic comparison “may involve no quantitative or statistical criteria” (Yin, 2013, Kindle Locations 3742-3744).

For the first option, strong causal inferences can be made in cases where outcomes for the expected pattern matches the empirical pattern from the findings (Yin, 2013, Kindle Locations 3667-3669). Some discretion can be given to the researcher, who may have been overly restrictive or too lenient when deciding if a pattern has matched or not (Yin, 2013, Kindle Locations 3747-3748).

The expected pattern matching in this thesis is based on literature on innovation in large organizations and the use of technology and integration in healthcare. The pattern matching is based on the non-equivalent dependent variable logic and compares the expected pattern with the empirical pattern. The latter is formed on the basis of the findings and the triangulation effort.

3.5 Validity and reliability

Yin, 2013 Kindle Locations 1613-1617 states that the quality of a case study is based on four different tests: construct validity, internal validity, external validity, and reliability.

Construct validity

The first one is about the concepts being studied and identifying how they can be measured (Yin, 2013, Kindle Locations 1626-1632). Steps that increase the construct validity includes the use of multiple sources of evidence, establishing a chain of evidence, and having key informants read and review a draft of the case study report (Yin, 2013, Kindle Locations 1624-1625; Kindle Locations 1654-1659). Data triangulation strengthen the construct validity through the use of
multiple sources of evidence (Yin, 2013, Kindle Locations 3195-3196). Having multiple sources of evidence allows the researcher to corroborate the same finding (Yin, 2013, Kindle Locations 3170-3186). It does, however, increase the burden of the researcher as it requires more time to do, as well as extra skill and knowledge (Yin, 2013, Kindle Locations 3204-3205). At the same time it helps to increase the confidence in the accurate portrayal of events (Yin, 2013, Kindle Locations 3198-3199). One way, for instance, to include multiple sources is to interview the same participant a number of times or on a number of occasions (Yin, 2013, Kindle Locations 3202-3204).

This thesis makes use of several sources of evidence, including several forms of observations, interviews, and documents. During the fieldwork it has also been possible to interview some of the same participants on numerous occasions about the same topics. This process has been time-consuming and most of the focus has been on the participants attached to Diffia. Key informants from that group has read and reviewed drafts of this thesis. Together, all of these sources of evidences have formed the basis of the empirical pattern.

Internal validity

The second test is mainly concerned with causal situations where the investigator “trying to explain how and why event x led to event y” (Yin, 2013, Kindle Locations 1663-1667). Strong or weak internal validity is linked to how well the investigator is able to infer events that can not be observed directly (Yin, 2013, Kindle Locations 1663-1670). Steps that increase the internal validity includes doing pattern matching, explanation building, and addressing rival explanations (Yin, 2013, Kindle Locations 1624-1625).

A more detailed view into the pattern matching process can be found in Section 3.4.

External validity

The third test is concerned with the generalizability of the findings beyond the immediate case (Yin, 2013, Kindle Locations 1676-1678). External validity for single case studies involves the use of theory (Yin, 2013, Kindle Locations 1624-1625). In particular, it relates to analytic generalization. Case studies are not generalizable to populations or universes, but to theoretical propositions (Yin, 2013, Kindle Locations 1071-1076).
Analytic generalization is about expanding and generalizing theories, and not to “extrapolate probabilities” as is done in statistical generalization (Yin, 2013, Kindle Locations 1071-1076). Inferences about a population are made from sample data in statistical generalization (Yin, 2013, Kindle Locations 1509-1510), and doing the same for a case study would be a fatal flaw (Yin, 2013, Kindle Locations 1514-1517). As a result, any analogy to samples and populations would, in fact, be misguides (Yin, 2013, Kindle Locations 1679-1681). Analytic generalization still strives to offer generalizations, principles, or lessons beyond the original case (Yin, 2013, Kindle Locations 1524-1527). Most often, the generalization is based on the theory in the case study and enhanced by the empirical findings, though it may also emerge from the findings alone (Yin, 2013, Kindle Locations 1530-1532).

Reliability

The fourth test is common for many kinds of research and concerns how well a later researcher could conduct the same study over again, by following the same procedures, and arriving at the same findings and conclusion (Yin, 2013, Kindle Locations 1695-1697). The goal is to minimize errors and biases (Yin, 2013, Kindle Locations 1697-1699), demonstrating that the operations of a study can be repeated with the same results (Yin, 2013, Kindle Locations 1626-1632).

One challenge related to reliability is the potential biases involved. In participant observation the role of the researcher as an external observer is limited, and may have to assume positions contrary to good practice based on it (Yin, 2013, Kindle Locations 3101-3105). Another common occurrence is that the researcher becomes a supporter of the group being studied if that was not already the case beforehand (Yin, 2013, Kindle Locations 2268-2271; Kindle Locations 3101-3105). These major challenges can affect the personal bias of the researcher. One way to combat this bias is to be open to contrary evidence and check the degree of how affected one becomes.

I was already working for the startup company before I began the current thesis topic. However, this is not a case where one startup is compared to another or even lightweight IT systems versus heavyweight IT systems. The thesis outlines how innovation the innovation process can play out, how this affects the clinical workflow, and how the integration will be handled. The events related to the case and how they were observed are outlined in detail in Chapter 4.

To that end, there were few conflicts encountered during the fieldwork.
people and organizations are mostly in agreement. They want more IT innovation in healthcare, they want to lower the threshold to get involved with IT innovation in healthcare, they want the process to be clearer, they want to break down the silo systems and support greater interoperability, and they want tools to be tailored to the clinical workflow. I have not observed that much conflict with regards to how this should be achieved. Some approaches include making it easier to test application and integration to healthcare IT systems and streamlining the process by reducing wait and confusion. Some disagree on how it should be done, by introducing apps first, or by introducing industry standards for interoperability first and then apps and other services.
Chapter 4

Case

This chapter is about the case. It starts off with a section about the background before moving over to the timeline and the stakeholders involved. The outline of this chapter is as follows: (1) case boundaries, (2) stakeholder information, (3) timeline and events, and (4) a summary of the case.

4.1 Boundaries

This section bounds the case with a background and an outline of the constraints of the case and the researcher.

Background

I am studying the innovation and integration process that takes place when attempting to integrate an app with EHR systems at hospitals. Some of the processes are technical—how can the app software communicate and transfer data with the EHR system software—but the larger part is organizational in nature. The health sector is a field where privacy is a top priority when dealing with new forms of technology in the clinical workflow. It is also a field where fax machines were used to try to bridge the gap between information silos at the different hospitals.

It is a place where innovation is called for by the clinical workers who create workarounds for existing software that limits their clinical workflow. One example is sharing patient data with other hospitals. The workaround includes printing out all relevant documents from one EHR system and faxing it over to another hospital where someone has to physically scan them and add them to their own EHR system. The industry is used to buying big ready-made systems that still
need some local modifications for each of the hospital use cases. They are not used to acquire a minimal viable product and helping the development as it happens with feedback and testing in the real-world environment to tailor the software to the actual needs the health professionals have.

This case follows the startup Diffia, who attempts to simplify the clinical workflow for nurses with an app to record patient vitals data. The app takes care of reporting the data to the EHR system which allows for a streamlined process where the nurses can focus on the clinical aspects. They do not have to worry about keeping track of the old paper form, that may sometimes be misplaced before they get the time to sit down at a terminal and re-enter the data into the EHR system by hand.

There have been a few stakeholders involved over the course of the integration process. The main stakeholders that Diffia has interacted with were Helse Sør-Øst, Akershus University Hospital (Ahus), Sunnaas Hospital, Sykehuspartner, and Medicloud. Perhaps surprisingly, DIPS has been in the background for most of this. Though this is mostly due to them only selling their product and have others maintain and manage the actual instances running at the different hospitals. A more detailed overview of the stakeholders can be found in Section 4.2 of this chapter.

Constraints

This case follows the startup Diffia in order to get research on the inside perspective of the innovation process. At the time, I already had access to Diffia as a part-time developer and the case study research benefits from this unique position that is not available to many. The organizational process in a small company is faster paced than large, public hospitals and allows for greater insight into the challenges faced with IT innovation in healthcare.

Unfortunately, the whole innovation and integration process took a long time and it was not possible to follow it to its completion in time allotted for this thesis. The relevant events are described in Section 4.3 in this chapter. I was not very familiar with the healthcare side of the case when the research started but the participants were able to explain any question I had about it. Their knowledge and experience helped shape the case, limiting the digressions and keeping it focused on the relevant parts of the innovation process. There are many opportunities to get sidetracked with the many stakeholders and sometimes confusing organizational structures. However, I was able to limit the case study and focus it on the steps
that were the likely candidates to further the innovation and integration process. Instead it was the time constraints that limited the scope.

**4.2 Stakeholders**

This section is about the stakeholders involved in the case research. The startup company Diffia is in the centre of the case. Other important stakeholders include the regional health authority Helse Sør-Øst and its subsidiaries, Ahus, Sunnaas and Sykehuspartner. The first two health authorities are hospitals and the latter is an organization that provides IT services for the other health authorities in the region. Supporting stakeholders mainly includes StartupLab, a startup incubator, but both the Research Council of Norway and Innovation Norway are important organizations that funds innovation projects and research. The major IT systems for clinical work found at the health authorities includes DIPS (several different versions) by DIPS and MetaVision by iMDSoft.

A simple overview of the stakeholders are given in Figure 4.1. Diffia is placed in the corner where innovation intersect health IT. The figure does not show how the different organizations have interacted with each other, but Figure 4.4 outlines the health authorities in a more hierarchical fashion.

**Diffia**

Diffia is a Norwegian health tech startup company. They want to create innovative informatics solutions that help doctors and nurses improve patient care and safety. They are working towards introducing a user-friendly lightweight app to give clinicians access to the patient data they need, when they need it. A mobile-first product made with the user in mind, integrated into the clinical workflow. Designed by health professionals and tested together with health professionals at Sunnaas, the app has an intuitive interface that helps healthcare professionals provide more targeted care. The app is called Nimble and this is the vision Diffia has for it. They know from experience how cumbersome IT systems can be when they are not tailored to the clinical workflow.

Nimble aims to allows nurses to easier register patient vitals as part of their clinical workflow. The app will integrate with their normal routines by replacing note-taking on a paper form, and Figure 4.2 illustrates how it can be run on several different devices. Another illustration of the app can be seen in Figure 4.3. When Diffia gets it integrated, the app will always be updated with the latest patient data.
It will also automatically send the vitals registration and notes to the electronic health record (EHR). The nurse is in control and the patient journal is kept up to date with only the minimal amount of input required.

The app is targeted to be used as part of the workflow where vitals data from the patient is registered. The data can be registered directly in the app when the measurements are made. With the paper-based process, the vitals are usually registered on a form, or just straight onto a copy of the patient list. The data is entered into the EHR after each patient or at the end of the shift. The paper form can be added to the patient folder and follows the patient.

The app, on the other hand, is always updated and available. Instead of a large form that contains every possible combination of questions and measurement, the app only shows the relevant questions at any given time. Any changes in the EHR and other systems will be reflected automatically in the app without having to manually sync or check for updates. To achieve this data interoperability the app uses open, industry standards. Most of the IT systems in the value chain...
do not yet support the FHIR and openEHR standards. In order to both benefit from using standards and to be able to communicate with non-compliant systems, Diffia is also making a separate application to handle this conversion between interfaces and data formats. This application is called the Lightweight adapter and is a middleware that sits between the app and the other systems in the value chain.

The benefit of separating the app and the software that can exchange data with non-compliant systems is that other apps and applications can use the Lightweight adapter. Any software that is compliant with FHIR could be added and it would translate its requests the same as for Nimble.

**Hospitals and regional health authority**

The Ministry of Health and Care Services (HOD) has the overall responsibility for healthcare in Norway. Its decisions are passed through to four regional health authorities (RHF), as can be seen in Figure 4.4. Each regional health authority governs a set of organizations, including a set of hospital trusts. In this thesis, almost all of the hospital trusts mentioned are hospitals. One exception is Sykehuspartner, which is not a hospital but is still set up as a trust. It offers IT services to the other hospitals instead.

In this thesis, we are looking at the Helse Sør-Øst (HSØ; South-Eastern Norway) regional health authority and a few of the hospital trusts (HF, Norwegian:
helseforetak) that is part of its region. Helse Sør-Øst is the largest of the regional health authorities and covers almost sixty percent of the total population in Norway. The hospital trust Diffia first planned to test and sell their app to was Akershus University Hospital (Ahus). Ahus offers healthcare services for about half a million people. The first hospital Diffia ended up testing their app with was instead Sunnaas, a specialty hospital. Sunnaas has around three thousand patients a year and focuses on rehabilitation for patients suffering function loss after sickness or injury.

Sykehuspartner is responsible for delivering the IT services for the other hospital trusts in the region. One of the groups in the Sykehuspartner organization is Medicloud, a group that aims to offer a platform to foster innovation in healthcare. They want to be an arena with a low threshold for people or companies wanting to experiment and make prototypes with integrations to hospital IT systems. Diffia has been in contact with them for several years and believes that their vision is great. Such a platform would most likely have helped them tremendously with the issues they have had with integration and test environment access.

The dashed arrows between the hospital trusts and Sykehuspartner in Figure 4.4 illustrates that the hospital IT needs and orders go through Sykehuspartner.
The work is queued up, but some projects get fast-tracked in a priority lane. C3, the Center for Connected Care, is an organization that researches innovation in healthcare and is part of the regional innovation initiative by Helse Sør-Øst. One of the benefits C3 gets from the initiative is that they have been given a priority pass with Sykehuspartner.

4.3 Timeline and events

This section is a narrative about the innovation and integration process case. It follows it from an inside perspective from the startup Diffia. The timeline is illustrated in Figure 4.5 and some of the main events are highlighted. Diffia was founded in 2013 but the events for the innovation process can be said to have begun in April 2015. As illustrated, the process is not complete as time constraints limited the scope of the case study research. The processes involved were simply too time-consuming to be captured in its entirety.
I have process structured the timeline into five phases: early days, prototype, getting office space, catalyst program, and testing and sales. In Figure 4.5 there is also a quasi-phase at the very end that indicates the time after this thesis was handed in. It does not, however, feature in the narrative. The duration of the phases are not always clear-cut and are meant as a way to organize the write-up and have been made up by me to increase readability. Sometimes an event happens in one phase and is only resolved or “updated” during another phase. One phase may thus refer to related events that only happen in a later phase.

Each of the following phases and their subsections contain a subset of Figure 4.5 that only show the timeline for their own specific duration. The subsections describes the events related to the innovation and integration process chronologically. Each of the subsections also contain a small summary of the events at the end.

**Foundation and early days** 07.2013 - 03.2015

The relevant timeline section is shown in Figure 4.6.

Diffia AS was formally registered as a company in July 2013 and the quest to innovate healthcare began. The aim was to create digital tools for health professionals that would be tailored to the clinical workflow. The two main founders had a background from working in healthcare and knew the current situation regarding
the use of technology as tools in healthcare. They believed the tools could be tailored better to the workflow. Their ideas and sketches centered around a website tool that would increase productivity among health professionals. The founders had other full-time engagements than Diffia at the time, but they worked on the product and their ideas when time allowed.

They knew their product would need to be integrated with the electronic health record (EHR) systems at different health authorities and they knew from their own experience and research that DIPS was the big market leader. In late August and early September of 2014, Diffia sent a couple of emails to DIPS where they ask them if they could send over some technical documentation about their systems. DIPS sent Diffia documentation on their API for the DIPS Message Broker and the DIPS API documentation.

Diffia also looked into getting remote access to Akershus University Hospital (Ahus) via VPN at around the same time as the email correspondence with DIPS. They asked Norsk Helsennett about VPN access to the servers on Ahus, but received the answer that they did not have a solution for it. They further recommended checking with Sykehuspartner as they did have some solution for remote access.

There was not a lot of product development during this time. Some ideas and approaches were explored but the founders were focusing their time on many other pursuits not part of the startup. This went on until around the second quarter of 2015.

**In summary** The startup company Diffia was founded in July 2013. They started sketching out what they wanted their product to be. They also had a few
short correspondences with DIPS, an EHR system provider that many Norwegian hospitals use, and Norsk Helsenett, the government owned company that provides a closed, secure telecommunication network for healthcare.

**Early prototype** 04.2015 - 01.2016

The relevant timeline section is shown in Figure [4.7]

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![Figure 4.7: The prototype phase of the process](image)

Diffia first met with Medicloud at the very end of April 2015. Both Diffia and Medicloud presented their own cases to each other, and seeing them as interesting, they agree to collaborate further. Medicloud is a group from Sykehuspartner that aims to lower the threshold for innovation in Helse Sør-Øst by providing a platform where products can be deployed and tested with integrations for the different
IT systems running at the health authorities. A platform running in a sandbox-mode with mock patient data available so that there is no need to be a full partner with complete, security compliant products to use it. Medicloud was participating at HelsIT 2015 in Trondheim and had contacted several projects about becoming pilot projects for their platform, same as they had with Diffia. A talk from HelsIT can be seen in Figure 4.8. The goal was to present the projects during the Innovathon part of the conference and showcase how each project integrated with the EHR systems and related products available on the Medicloud platform. This was a great opportunity for Diffia to get their product closer to production and in use at a hospital.

Figure 4.8: A talk at HelsIT. Source: Kai Dragland

With only around four months until the conference in October Diffia decided to scope down their vision for the product and develop a working prototype with the necessary integrations to DIPS. At this time their idea for the product had changed slightly. It was still developed with web technologies, but it was now sketched to be a web app that could leverage the mobile benefits of smartphones. Diffia also hired a part-time developer during this time to help them build the app within the time frame. The outlook was good and Diffia attended a meeting with Medicloud and IBM in early June 2015 where IBM Bluemix were presented as the technical cloud infrastructure. Medicloud plans to work with DIPS to deploy a test instance of their DIPS Arena software and new openEHR API to the platform. This would allow the pilot projects to develop integrations with the DIPS instance before the HelsIT Innovathon. The aim was for the products to run on the Bluemix platform and be production ready in early 2016.

In an email from Medicloud in late August 2015, they confirmed that DIPS was on board and that test data would be available, as well as an API to read and write data to the patient journal. The process was slow-going however, and Medicloud introduced Diffia to a person with a background from the IT consultancy industry and the heavy bureaucracy from a large organization in the public sector in order to help support the product development. There were more setbacks, un-
fortunately, as the openEHR API and DIPS Arena instance was confirmed to be
delayed further, with Medicloud looking into it.

I started working for Diffia in the beginning of October 2015, about half a
month before the HelsIT conference. One of the founders enrolled in the bachelor
program for Informatics: Design, Use and Interaction at the University of Oslo in
the fall semester of 2015. I had been one of the buddies (Norwegian: fadder) for
his group when he started so we knew each other and talked when we met in the
hallways at the Department of Informatics (IFI) at the University of Oslo. At the
time I knew he had a startup trying to make it in the health tech industry but not
much more than that. Diffia, on the other hand, began to see their scoped down
prototype slowly taking shape and were looking to hire another developer to speed
up the development process. The founder from Diffia asked if he could pitch the
startup for me and a couple of meetings later we agreed to try and see if it would
work out. I started working part-time for Diffia in October when the big deadline
for the Innovathon at HelsIT was only a few weeks away.

I attend the HelsIT 2015 conference on the 20th and 21st of October together
with a few of the people from Diffia. It is a conference for people connected in
some way to the healthcare industry. There were health professionals and health-
care system providers in attendance as well as researchers and us from the dif-
cerent Innovathon pilot projects. We were most focused on the track set aside for
the Innovathon and the presentation of the different pilot projects. Diffia had a
good pitch prepared but despite the accelerated development process Medicloud
had not managed to deliver a DIPS Arena instance with test data on their cloud
platform. The working prototype Diffia had produced was not integrated with any
EHR system. None of the other pilot projects were integrated either, but neither
were they as keenly dependent on such integration as Diffia.

There was some last minute fixing on the prototype in the hotel room before
the conference started and Diffia was able to show the audience the app as part
of their presentation. In a section near the end of the conference three of the
pilot projects got to present their product before the main audience as part of the
main track. Diffia was one of the three that got selected. Diffia were actively
participating for most of the conference but there was time to mingle and talk
with people from their network who also attended.

Innovation was a hot topic at the conference and many were sharing their
experiences, both when mingling and when presenting in front of an audience.
The conference was a great opportunity for Diffia despite the lack of a proper
test environment. The prototype was running on a phone and displayed on the
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projector, with the server software running on a laptop Diffia had brought along. The attendees were in good spirits, however, and the set up performed well for the task. I felt many of the attendees had this positive attitude and I was able to familiarize myself with the state of the health and health tech industry from a different source than just Diffia. I experienced a vibrant community where both presenters and attendees where open about their experiences and discussed how to improve their work facilitate for better patient care in ways that were adopted for the clinical workflow. There were those who did talk about the issues they had experienced with technology, but in the talks I had time to attend they were focused on possible solutions and not fixating on the problems themselves.

Medicloud invited all of their pilot projects to a seminar about a month after the HelsIT conference. In it, the retiring director of Sykehuspartner was praising the Medicloud project and said there was a big demand for test environments and integrations to EHR systems. He also expressed disappointment about the time frame and that getting production ready took longer than predicted. The DIPS integrations were still planned as part of Medicloud but the time frame for it was not specific.

In summary Diffia first met with Medicloud at the very end of April 2015. They took part in the Innovathon at HelsIT 2015 as one of the Medicloud projects. I was hired in the beginning of October 2015 and helped develop the prototype Diffia presented at the conference. Diffia continued to meet with Medicloud but the test environment with the DIPS electronic health record (EHR) system populated with mock patient data was not realized during this phase. The prototype was also developed with as much productivity as the part-time resources could manage.

Getting office space 02.2016 - 08.2016

The relevant timeline section is shown in Figure 4.9

Diffia had part-time development resources but they lacked any office space. Communication was done mainly over the phone or through Skype meetings and Slack (discussion application) discussions. The actual programming was done by the developers at their home or at the university, and the development process was tracked with tasks on Trello. There had been a bit of a rush before the HelsIT conference to get as much done as possible. It went mostly well for each to work on their own part of the prototype but there were a couple of times when a few met at IFI (department for informatics) for a “mini workshop” where we sat together
and worked. IFI was also used as a location for a few of the meetings that were held in person, and again it worked out well for the most part.

The lack of a permanent office space was starting to get more keenly felt. It was not yet an issue during the early months of 2016 but the accelerated development process meant that it was discussed a lot. The prototype was progressing to the stage where further design was getting more complicated and required a tighter feedback loop. By the end of the first quarter of 2016 Diffia had enough of an infrastructure in place for their web app to start focusing on tailoring their features for the clinical workflow. The early prototype had shown a lot of promise but it was time for the founders to impart some of their experience with the healthcare industry and clinical workflows into the app. Diffia was also looking for more development resources and wanted an office space that was not too expensive, but could provide enough space for a few people. Everybody was still working part-time for the first part of 2016 but the plan was to work full time during the two summer months.

Diffia moved into a few desks in an open office landscape at StartupLab in the beginning of April 2016. The office space included more than just desks, as can be seen in Figure 4.10. At the time Diffia was told that there was a big demand and only one out of ten applications to join were approved. StartupLab is an incubator for technology and innovation and we were told when we moved in that there were around sixty other startups in the lab. They even try to promote a creative atmosphere through their website, shown in Figure 4.11. The environment and atmosphere at StartupLab were very conducive for working with innovation and
sitting together when we worked added to the excitement. The team now had a permanent office to go to and hold meetings and workshops. However, for most of the meetings, Diffia would still meet at the location the other party chose.

One of the events that Diffia attended was the eHelse 2016 conference in Oslo. It took place at the end of April and I was there with one of the founders. The eHelse conference, like HelsIT, is targeted at the people in the healthcare industry and the technology industry. It is an arena for those who wants to share their experiences and discuss the future for IT in Norwegian healthcare. Diffia did not present anything or give any talks but used the opportunity to network and mingle with other stakeholders in the industry. Support for a few innovation projects was announced and, like at HelsIT, innovation was a hot topic among the attendees. The talks were about existing solutions, like the core journal (kjernejournal), and the experience people had with it, as well as talks discussing the benefit of (sharing) healthcare data. The talks I attended displayed a lot of positive attitudes but there was also some talking about how there was still much to improve.
We met and worked together on the design and programming during the two first months at the office. Diffia also met with Medicloud a few times but there was still no news about a test environment with DIPS instance running. DIPS would not be the only system that the app would need to be integrated with. Other systems included the IAM (Identity and Access Management) system that controls who has access to what and MetaVision, a software system used in the ICU. The meeting regarding IAM was with Medicloud in late May 2016 and the meeting about MetaVision was with EVRY in early June 2016. Neither meeting led to anything concrete, though they both added to the importance of having a test environment that is running systems and components it is possible to integrate with. Diffia was also engaged in an email correspondence with Medicloud in the beginning of June where Diffia sent over clarification of the boundaries, needs, and requirements for the project on request from Medicloud.

The rate of development was good during the summer but the organizational processes were slower. Diffia had a few meetings and attended a workshop with Medicloud in June but nothing major happened with the integration process during July. The meeting was with Sykehuspartner and concerned the application Diffia wanted to run in the test environment and the type of data the app would need to exchange with the EHR system.

The workshop was with Medicloud and IBM, and Diffia was invited to attend a part of it and provide feedback. It was led by experienced designers and facil-
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<table>
<thead>
<tr>
<th>#</th>
<th>Pain point</th>
<th>Big idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No easy way to start</td>
<td>How might we help the persona get started or inspired?</td>
</tr>
<tr>
<td>2</td>
<td>Lack of reusable components and APIs</td>
<td>How might we help the persona leverage what has already been created to build faster?</td>
</tr>
<tr>
<td>3</td>
<td>Lack of end-user focus with tools</td>
<td>How might we help the persona understand the value of the service or API to the end-user of his or her application?</td>
</tr>
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Table 4.1: Some of the data from the Medicloud and IBM workshop

Representatives from IBM provided feedback based on their own needs from such a platform. The workshop was organized and facilitated by IBM representatives, which provided a platform for identifying and designing solutions for the Medicloud vision. Participants from Diffia provided feedback based on their own needs from such a platform. The goal for the first day was to identify the top level pain points the potential customers of the Medicloud platform experienced with the current, non-Medicloud, system. This was also the day Diffia attended. The top three pain points revolved around the issues and frustration of getting into the health IT sector, the lack of reusable components and APIs and where to find and get access to them, and the lack of focus on the end-users’ perspective.

The participants all agreed that it was practically impossible for anyone new to the health IT sector to have any success with even starting a project and getting anywhere with it if you needed to integrate with even small parts of existing services or infrastructure. The topic was brought up several times during the workshop day, and while it was mentioned that Diffia was better positioned due to the clinical background of the founders and their connections in the domain, it was generally agreed that the benefits merely made it possible, but that it is still far from easy. One main issue that was brought forth on several occasions was the organizational aspect, and how difficult it was to get anywhere without going through several people and layers of bureaucracy over a time period measured in months. Another issue mentioned throughout the workshop day, as well as being a major pain point, was the lack of APIs and access to test servers. Access is hard to come by, and it was suggested that the best way, if not the only way, would be to get hold of a person that was connected to the project you wanted to interface with and have him or her give you what you needed. The workshop focused on the needs and on top level concepts. As such, there was little talk about actual integration to existing infrastructure since it was not relevant to the goal of the workshop.

August 2016 presented little in the form of progress on access to a test envi-
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ronment and integration and I had transitioned back into a part-time role at the beginning of the month. The founders, on the other hand, were continuing in a full-time capacity and preparing for the StartupLab and Telenor Catalyst program starting in September.

In summary Diffia applied for office space at StartupLab and got it approved in beginning of April 2016. One of the founders from Diffia and I attended the eHelse 2016 conference at the end of April. A couple of people from Diffia and I attended part of a workshop held by Medicloud and IBM that focused on a few things. The day Diffia, attended the aim was to identify the top level pain points the potential customers of the Medicloud platform experienced with the current, non-Medicloud, integration process. The findings from that day of the workshop are summarized in Table 4.1. Diffia had attended many more meetings but they still had not gotten much further with the actual integration. The development progress had increased as several people were working full-time on it. Diffia had also applied to the Catalyst program, run by StartupLab and Telenor, and been selected as one of the candidates.


The relevant timeline section is shown in Figure 4.12.

![Figure 4.12: The catalyst program phase of the process](image)
StartupLab was not only a place where like-minded people shared an open office space. The leadership had a lot of combined experience from the startup world and they provided mentor services and arranged events and pitch parties. Figure 4.14 show an example of one of their events. Startups could get advice from lawyers and business advisers, other startups investors. One of the programs run at StartupLab was the three-month long accelerator program Catalyst that they arranged together with Telenor. Six startups got funding and a full timetable of mentoring and the help they needed to sell their product or service with that important first customer or group of customers. Diffia had heard of the program, and likely everyone else in the lab had too, but they did not at first consider entering into the competition. The program had several taglines, with the main one illustrated in Figure 4.13.

The word around StartupLab was that there were a lot of startups signed up already, most of them not already at the lab, but Diffia did not think that the goal of accelerator was all that feasible for their case. The program would provide funding that would allow Diffia to hire more resources, but they felt that their main issue was external. It was not really the rate of development that made it hard for them to sell their product, though more development resources would go a long way to tailor and polish their product. Instead, it has been the slow and pondering nature of large, mature healthcare organizations that has had them most concerned. Their background is in healthcare and so they know it well, but it was still challenging to navigate. The recurring example is the test environment that was always outside of reach. Diffia had asked Medicloud for a status update about it in late August, and wondered where they were on the issues with licensing and DIPS in the test environment previously discussed in the summer. The response was that the situation is being handled but that the process is slow. What the accelerator program seemed to promise was an increased internal pace and not one that would speed up external organizational processes.

Diffia had regular meetings with their handler at StartupLab and was recommend to nevertheless apply for the program. There were many benefits that could be gained from an accelerator, and the resources to continue improving their product was only one of them. The program also required the founders to work on the startup full time. Another benefit of the program was the support network around it and the experienced people there to help. One of the themes that are visited and revisited at StartupLab and related other startup events is the ability to pitch your case. The way in which one is able to communicate the work one is doing to someone who might not even be in the same field as you and knows nothing of
the terminology or the culture. The healthcare industry is a complex field all by itself, and that is before you add technology and innovation into the mix. Diffia knew the healthcare crowd and they were well versed in technology by then but one of the challenges is to pitch, to communicate, your case to all of the different stakeholders and their diverse backgrounds. The accelerator did promise to help with that, and to provide resources for further development and a supporting base of operations.

The Catalyst program started in the beginning of September 2016 and would last for three months until the end of November. Diffia had applied, been selected for the second round, and finally offered funding and a spot in the program. In the beginning of September and the Catalyst program, Diffia and Medicloud discussed meeting more often and Diffia asked if there are any tasks they can contribute more to. Medicloud suggested that they should meet the week after, when they know more about the status and can better distribute the tasks. One of the documents on the product that needs approval before it can be used in a test environment with sensitive, real-world data, would be the ROS (Risk and Vulnerability, Norwegian: Risiko og Sårbarhet) analysis. Another document is the Design Solution (Norwegian: Løsningsdesign). Both documents provided information about the product that the stakeholders that have the overall power to approve the project want available in order to make an informed decision. Sykehuspartner is
the organization in Helse Sør-Øst that writes these documents on orders from the different health authorities in the region. Unless given strong prioritization, the new orders get added to the bottom of the queue.

An ROS analysis identifies the potential risks and vulnerabilities of the product and outlines possible actions that can be done to handle incidents. While it is a very useful document to have, it can slow down the process quite a bit. For traditional projects in the health sector that follow well-established and conventional procedures it appears to not be much of an issue. However, Diffia experienced a bit of a circular process surrounding the ROS analysis. The Data Protection Officer wanted to have the ROS analysis in order to be able to make a decision about approving the product, and there were some issues with getting a ROS analysis order through before the Data Protection Officer had approved it.

This eventually got sorted out and it was decided that the ROS and Design Solution needs to be done before the eventual approval from the Data Protection Officer. Diffia got an example ROS analysis from Sykehuspartner in early September. This was in order to familiarize themselves with the type of document and to use as a reference to draft one themselves for their app. When the order from Sunnaas to Sykehuspartner to create the ROS analysis and Design Solution would eventually be sent, Diffia wanted to their drafts to follow along as a reference and in the hopes that it would speed up the process. The next issue that needed to be
resolved concerned the cost and who should budget it. The work to get the cost estimation from Sykehuspartner was started on but only got formalized and sent off later, around the turn of the year.

As such, the long days during the Catalyst program involved many meetings, many emails, and many phone calls. The vast majority of the stakeholders were positive and encouraging. Diffia experienced that many they met or talked with shared much of their frustrations and wants regarding improving clinical workflow. Some of the issues with this non-traditional approach were that the many stakeholders need approval from other stakeholders before themselves approving the project. A simple segmentation of these stakeholders can be seen in Figure 4.15. The clinic stakeholders might only approve if there is a need by the department level, who can only commit if the administration and clinic level approve. The result is that Diffia tried to get a little bit of approval from all of the different stakeholders until one level gives full approval. Then repeat the process for each stakeholder. Once full approval would be given by the hospital then it would be possible for them to put in the orders to Sykehuspartner. They get orders from all of the health authorities in the region and adds them to a backlog. Diffia has experienced this process to be very slow. Sunnaas had to wait a few months to get the cost estimation of the ROS and Design Solution back from Sykehuspartner. The actual orders for the documents are then added to a new queue.

![Figure 4.15](image.png)

Figure 4.15: A simplified segmentation of the layers of decision makers in the hospitals and regional health authority

There was also another meeting with Medicloud and the department of integration from Sykehuspartner and IBM about access to a test environment. Diffia was informed that Medicloud would not be production ready in 2016, but was aiming for a release next year instead. Another issue that slowed down the process was an issue with access to one a temporary test environment at Ahus. De-
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spite working with Sykehuspartner, Diffia did not have an explicit data processing agreement with the health authority on their own. That caused an incident but everyone involved was open about it and the investigation was able to cover it fully. The incident showed that an explicit agreement was needed between the hospitals and Diffia. Such an agreement was applied for shortly after the need was uncovered but every interaction and process was put on hold until the incident report was complete and the issue resolved. Once it was resolved, the data processing agreements were made and the other processes continued.

A test environment with mock data was still unavailable. However, Diffia still wanted to test the app in a hospital setting. Without integrations to the EHR system, those features would have to be mocked. That made it possible to test the app with real nurses, in a hospital setting, and incorporate their feedback.

In summary The Catalyst program started in the beginning of September 2016 and would last for three months until the end of November. There were many meetings and discussions about the necessary agreements and documents needed to test the app at a hospital, such as a data processing agreement, ROS (risk and vulnerability) analysis, and Design Solution (Norwegian: løsningsdesign). Diffia also reached out to Sunnaas Hospital about testing the app, though a test environment with mock patient data was still not realized during this phase.

Testing and sales 12.2016 - 03.2017

The relevant timeline section is shown in Figure 4.16.

The app was originally aimed to be used in the emergency room at a hospital. One of the founders of Diffia had worked as a doctor at Akershus University Hospital (Ahus) and had a big network there. Ahus also has the largest capacity in their emergency room in Norway. It was a natural place to start and test the app. Diffia knew the hospital, the emergency room, the health professionals, and they knew the clinical workflow there. Being a large, mature organization, processes seems to take a long time at the hospital. For Diffia the process of integration and testing has been going on for years. A great many of the issues seem to be related to the lightweight approach to IT that Diffia follows. It is not a process the hospitals are used to. Big software suit licenses will often be acquired as part of the regional strategy and each hospital set it up as part of their IT infrastructure. Diffia has a small, lightweight IT product in comparison. Their process reflected the product and the size of the company. They followed lean and agile principles where they can make decisions as they are needed—when you are in a position
with the most relevant knowledge—instead of doing everything up front. Diffia was having issues with getting real traction with all of the stakeholders at Ahus with this process. Not all hospitals are as large as Ahus, however, and is better able to adopt their processes on a shorter timescale.

Sunnaas Hospital, parts of which can be seen in Figure 4.17, is another hospital in the Helse Sør-Øst region. It treats around three thousand patients a year and specializes in rehabilitation. The focus is on patients with complex functional impairment as the result of disease and injury. Diffia had approached Sunnaas about testing the app with them as part of an innovation project. Forskningsrådet in Norway has a program called VRI (Norwegian: Virkemidler for regional FoU og innovasjon) that financed innovation projects. Sunnaas and Diffia applied for VRI funds that would pay for Diffia testing the app together with nurses at Sunnaas.
The field study conducted at the stroke ward of Sunnaas was designed to compare their current process and the process when using the app by Diffia. One part of the study was getting feedback from the ward staff that tested the app and have them familiarize themselves with how the app worked. When measuring the current process the staff had all of the tools they usually have available–patient lists, pen, paper, phone, colleagues, computer, charts, etc–at their disposal. This was compared to a process were the staff used a basic version of the app to view and register patient data.

The study consisted of five rooms: a nurses station, a medicine room, and three patient rooms. The average time spent when using the current, traditional workflow was twenty-nine minutes. The staffer had to constantly go back and forth between the patient rooms, the medicine room, and the station for the nurses. On average, the staffer went to eleven rooms during the traditional process. During the workflow with the app, this number was averaged to five rooms and the staffer did not have to go back and forth between the different rooms. The average time spent was fourteen minutes, saving a quarter of an hour. The field study was a great experience for Diffia and Sunnaas both, and was summed up nicely by the Director of innovation at Sunnaas: “the feedback from our wards has been overwhelmingly positive”.

While Sunnaas was not the original choice, the hospital turned out to be a great collaboration partner for the project. They were very enthusiastic and had a positive attitude to Diffia and the innovation process. Although they were not able to test a version of the app with the proper integrations, they believed in the
product and that Diffia could help "blaze the trail" for later projects. Sunnaas also have indicated that they want to put in an order for the app, but it is on hold while the ROS and Solution Design documents are written by Sykehuspartner and Diffia can test the app with proper integrations there.

Diffia was also busy with trying to get acceptance for their project at the director level at Ahus and Helse Sør-Øst. They had improved the app, their presentation, incorporated the findings from the collaboration with Sunnaas. Many meetings later and they started to get meetings with the leadership of the region and with Sykehuspartner. However, they were not able to get their app deployed and in use, or even proper access to a test environment in the given time-frame of this case.

Sykehuspartner did get back to Diffia and Sunnaas in early April 2017 about the cost estimate for the ROS analysis and the Design Solution. This was just over three months after the order had been sent in. The order was then put in the queue to get started on, but this too was outside of the time-frame of this case.

In summary Diffia tested the app together with Sunnaas Hospital in December 2016. Some of the results can be seen in Figure 4.18, and the use of the app lowered both the complexity and the time to perform the tasks. In early January 2017, Sunnaas (together with Diffia) asked Sykehuspartner for a cost-estimate of the ROS (risk and vulnerability) analysis and Design Solution (Norwegian: løsningssdesign) documents for the app to be used at Sunnaas. Three months later, in early April 2017, Sykehuspartner sent the finished cost estimate back. The estimate for the documents totals fifty hours, at twenty-five hours each, to create the documents.
Chapter 5

Findings

This chapter describes the findings and empirical pattern that emerged from them.

5.1 Case data

This section summarizes the case data into different findings. These are grouped by different subsections based on a common theme.

Starting point and single point of contact

It is difficult to know where to begin when you as a new company want to create IT solutions for the healthcare industry. There are no guides or overviews available, and no single point of contact to help you out. Some of the founders of Diffia had a background as health professionals and one had worked as a doctor at Akershus University Hospital (Ahus). Their combined network gave them a big advantage and lent them a great deal of credibility when asking for sit-downs and meetings. However, it was still challenging to know which organization or people to contact. Having a great idea is often not enough to start out in the IT healthcare industry. You need to gain access to the right people, or the right people who can put you in contact with the right people.

The organizational structure can be very confusing, especially when you come from the technology industry and do not have that much experience with the healthcare. Diffia had a lot of knowledge about how the hospitals were structured internally but the exact processes involved in IT innovation was not always been very clear. There was not a group that acted as a single point of contact that would guide you through the process, and that could help with any questions you
CHAPTER 5. FINDINGS

might have. Instead, Diffia needed to find and talk with a lot of different stakeholders on all levels of the organizations. They met Medicloud early on for the HelsIT conference, however, Medicloud is only a small group in a large healthcare organization. They needed to get the approval of IT managers, stakeholders on the department, clinical, director, and CEO levels (Figure 4.15). A lot of people had to be involved in different degrees of decision making, until a “critical mass” of smaller approvals have been made and a turning-point decision can be made at the top level.

Required agreements and documents

There are a few different agreements a company needs to during the innovation process. A few of them deal with collaboration between the company and the hospital. Some deal with access to patient data and how this access and data should be treated by the people with access. Other documents were specific to the app you want to run at a specific hospital. These agreements can often be made between the company and the hospital directly, but some of the documents relating specifically to the product can only be ordered through Sykehuspartner. The exact combination of required agreements and documents are somewhat dependent on the situation. If, for example, you have a product that you want to have access to patient data then that product will need to have its ROS (risk and vulnerability) analysis and Design Solution be approved, as well as security certified and approved by the data protection officer. This is required even if the patient data in question is only available in a test environment, but copied from a production database. The company will also need to have a data processing agreement with the hospital where the test environment is set up. Sometimes it is unclear which organization or department should budget an order and finding out slows down the process.

This process is not always clear. Diffia thought they had a good overview of the required agreements and documents. However, there was an incident where they were originally approved to test against a data set, but got that access blocked due to a missing agreement for that specific case. The incident was resolved but it was time-consuming and the rest of the processes was placed on hold until it was resolved. Although the app Diffia has developed is the same they still need to have it approved separately for different hospitals.
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Test environment

Long before a company can get to the point where they can offer a hospital to buy their product, it will have to be integrated with the electronic health record (EHR) system running there. The ability to integrate is dependent on having access to a test environment with data to ensure that the systems work as intended before deploying it to a production environment. Sometimes a product can be tested in several different test environments. One where the developers can rapidly deploy new versions of their product to in order to test different aspects. Another can be a “quality assurance” (QA) test environment that is deployed to less frequently but can be used to test the product in as near an environment to production without actually being in the production environment.

![Figure 5.1: The IT systems currently used in the Helse Sør-Øst region. Source: Helse Sør-Øst Digital Renewal project](image)

The findings show that test environments in Helse Sør-Øst can be elusive. They seem to usually be set up for specific projects and they run with data copied from the production databases. This means that any system that wants access to this environment would in effect need to be as fully approved and certified as any system running in the production environment. When the available data is sensitive, real-world data it requires an app and the company developing it to
have all of the same agreements in place, as well as any other documents, security certifications, and approvals to assure safe handling of the patient data.

There is a push to set up a test environment with mock or anonymous patient data, but so far it has not come to pass. With the current process, it is difficult to test any sort of integration without expending a great deal of time and resources on getting access to the available test environment. This is in large part due to the sensitive, real-world patient data. There is also an issue where the product might need to be partly approved anew because it would have changed too much compared to when it was initially approved. This makes testing very challenging. However, Diffia did not get this far in the time-frame of the case and it could be that such updates would be trivial.

One complication relating to the different systems running in the test environment concerns interoperability and data exchange. Not every system exchanges patient data the same way and some of them use their own specific data format. This can be overcome, but can add extra layers of complexity to what would otherwise be a very simple app. The solution Diffia proposes, and have started on, has been to develop a separate “middleware” service that knows how to exchange data with all of the heavyweight IT hospital systems. This allows the simple app
to only exchange data using FHIR, a modern industry standard for patient data exchange from the international non-profit organization HL7. An overview of the different IT systems running in Helse Sør-Øst region can be found in Figure 5.1 and 5.2. The first figure shows the main IT systems currently in use and the latter shows the ones they plan to run at the end of their Digital Renewal project.

Testing in the clinical workflow

One aspect that the findings show as very positive, both by Diffia and the nurses involved, was the app testing with Sunnaas Hospital. Although the founders themselves have worked as health professionals and know the clinical workflow they are also the ones designing the app. This intersection of knowledge and decision making powers can streamline early design and helps keep the app focused on the important tasks. However, external feedback from the average users that will end up using the app when it is production ready is a precious resource that helps uncover issues with the supported workflow and problems with usability. Another benefit is that they can share their experience and influence the next iterations of the design.

Figure 5.1: A scan of the form used at Akershus University Hospital (Ahus) to register patient vitals data. Source: Ahus

This close collaboration and experience gained by usage during testing have the potential to benefit later stages as well. The nurses that have been part of the testing can act as ambassadors for the app and answer questions about it and its use when the product is finally in production. They can bridge the gap between the end-users and the developer and streamline the adoption process as they are easier to approach and have prior experience with the product and how to use it effectively. This late-stage was not possible to study in this theses, however, due
to time constraints and long-running processes. The findings only suggest that the reception in such a stage would be good and that even the nurses who did not use apps that much in their everyday life saw the usefulness of the app by Diffia during the clinical workflow. A scan of the paper form used for registering patient vitals data can be seen in Figure 5.3. Though the routine has some variation between hospitals and the different hospitals use different forms.

5.2 Empirical pattern

This section describes the empirical pattern based on the findings and can be found in Table 5.1.

**Pattern outcome 1**

The empirical pattern outcome for this section is: *Diffia has not had the resources necessary to enable testing without effectively going through the same processes as a production-ready product available to them.*

The findings show that resources valuable to the innovation process were not made available to Diffia. The test environment with mock patient data is a prime example. Integrations with existing electronic health record (EHR) systems is a key aspect of the functionality that Diffia wants to provide in their app. However, any meaningful attempt at integration will have to be tested against such heavy-weight IT systems as EHR systems. This requires a test environment where those systems are installed, and it requires that the system is populated with patient data. Sometimes, some new heavyweight IT system is introduced or existing ones are changed, and then Sykehuspartner will set up a test environment for that particular project. These environments are per project and specific to the particular hospital. Getting access to such an environment is non-trivial, put potentially possible for an outside startup like Diffia provided the right agreements are signed.

There are several issues, however. One of them is that the environment follows the project and when that is completed the environment would be shut down and Diffia would lose access. Even if it was not shut down, there would still be a problem regarding the patient data. The test environments that Diffia has heard of or encountered has all used sensitive, real-world patient data copied from production databases. While Diffia may sign agreements that allow them to see those patient data, it does not mean that their app is approved to be run in such a test environment. Using patient data from the real world means that the app would
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# Empirical pattern outcome

1. Diffia has not had the resources necessary to enable testing without effectively going through the same processes as a production-ready product available to them.

2. Diffia has been going against the grain of the current processes and it has involved many stakeholders across organizations.

3. Diffia has needed approval for their product on several internal management levels.

4. Diffia have encountered and met with many people that have been dedicated to sharing their experiences with technology and innovation in the healthcare industry.

5. Diffia has been working as a self-contained unit and have been able to successfully test their app with Sunnaas Hospital.

6. Diffia has been able to use its combined network to getting closer and closer to the decision makers.

7. The IT systems used in the Helse Sør-Øst region is managed with a silo mentality.

8. Diffia tested their app with Sunnaas and the data from the test shows a reduction in time and complexity of the clinical workflow.

9. Diffia encountered positive attitudes when they tested their app with Sunnaas Hospital.

<table>
<thead>
<tr>
<th>Table 5.1: The empirical pattern</th>
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<tr>
<td>1. Diffia has not had the resources necessary to enable testing without effectively going through the same processes as a production-ready product available to them.</td>
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<tr>
<td>2. Diffia has been going against the grain of the current processes and it has involved many stakeholders across organizations.</td>
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Having a test environment available with mock patient data would allow developers to test the integration possibilities as they are needed by the functionality the developers want to provide. They would not need to go through all of the time-consuming and costly processes with each hospital before they could get the necessary integrations in place. Another benefit would be that when such a company was ready to test their app with a hospital, it could be tested in a more realistic setting with integration to test versions of the real heavyweight IT systems and

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mock patient data.

**Pattern outcome 2**

The empirical pattern outcome for this section is: *Diffia has been going against the grain of the current processes and it has involved many stakeholders across organizations.*

The findings show that the innovation process Diffia has been going through is not well supported in healthcare organizations. The hospitals are not used to facilitate processes that are abnormal to their standard operations. However, some hospitals are in a better position to adapt their processes and attempt to foster IT innovation. Sunnaas Hospital showed enthusiasm and commitment in making it easier to innovate when Diffia wanted to test their app with health professionals in a clinical setting. Still, the current processes are not geared towards innovation and it is often an uphill struggle to approval. Another example is how seemingly impossible it has been to gain access to a test environment with patient data that is not copied directly from production databases.

**Pattern outcome 3**

The empirical pattern outcome for this section is: *Diffia has needed approval for their product on several internal management levels.*

The findings show that Diffia has needed approval for their project and product on several management levels in several healthcare organizations. The app is a lightweight IT system and it is made by a startup company that is outside the established health IT organizational sphere. The systems normally acquired by the hospitals tend to be large heavyweight IT systems with long histories in the healthcare industry. While the heavyweight IT systems can be selected as part of a regional strategy, such as the Digital Renewal program at Helse Sør-Øst, lightweight IT systems do fill the same role. Thus, the acquisition process is different. Diffia has experienced that they have needed to document that there is a need for their product, that the health professionals want to use it, and that it fits in with the regional strategy. All of this has required them to go back and forth between different levels of management in order to get one more approval. Once the project is fully approved, the hospital can take the case over to Sykehuspartner. Which have their own process that can be time-consuming, even if all the hospital asks for is a cost estimate of a few documents for a lightweight IT app.
Pattern outcome 4

The empirical pattern outcome for this section is: *Diffia have encountered and met with many people that have been dedicated to sharing their experiences with technology and innovation in the healthcare industry.*

The findings show that health professionals are concerned about IT innovation in healthcare and they like to share their experiences. There are several conferences for technology and healthcare, HelsIT and eHelse being two of them. There is also research groups, such as the FIGI project, and organizations that support healthcare, such as Oslo Medtech and C3 (the Centre for Connected Care). Diffia and their app have been met with a lot of positive attitudes, on all of the arenas mentioned. They are also concerned that despite all of this goodwill the process has still been very slow for them. It has not been easy for Diffia to absorb the cost of this innovation process over several years without making a formal sale.

Pattern outcome 5

The empirical pattern outcome for this section is: *Diffia has been working as a self-contained unit and have been able to successfully test their app with Sunnaas Hospital.*

The findings show that Diffia has been able to leverage its organizational structure as an independent company to great effect. They began their efforts at IT innovation and integration in healthcare with Akershus University Hospital (Ahus) in mind. They knew the organization well and one of the founders had worked there and knew the community and the other health professionals. Ahus is a very large organization with mature processes, and it turned out to be challenging to fully integrate with the IT systems there in a timely fashion for a startup company with little up front funds. Being independent and self-contained allowed Diffia to turn their focus to Sunnaas Hospital while they waited for the process to progress at Ahus. Sunnaas was enthusiastic about IT innovation and improved digital tools tailored to the clinical workflow, and was able to adjust their processes to facilitate the innovation process. This would not have been as easily achieved had Diffia been an internal group attached directly to the Ahus organization and their processes. As such, Diffia is able to work with several hospitals in Helse Sør-Øst at the same time, though at different speeds.
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Pattern outcome 6

The empirical pattern outcome for this section is: Diffia has been able to use its combined network to getting closer and closer to the decision makers.

The findings show that the combined network of people that Diffia has accumulated over the years has been a valuable asset. Their network has helped to open doors and grant meetings with more and more influential people and decision maker in the management chain. Some of the people in their network are health professionals working in the hospitals, while others are in management positions. Sometimes a person they know will have gained a different position and has been able to put Diffia in contact with other decision makers previously unavailable. Though, some of this can also be attributed to a stronger product and results from the testing with Sunnaas Hospital.

Pattern outcome 7

The empirical pattern outcome for this section is: The IT systems used in the Helse Sør-Øst region is managed with a silo mentality.

The findings show that the IT systems in Helse Sør-Øst (South-Eastern Norway regional health authority) is managed with a silo mentality. The regional health authority (RHF) is attempting, however, to use IT systems that are more interoperable, with some of this effort being pushed through as part of their Digital Renewal program. The IT systems at the different hospitals are not able to communicate directly together and sharing patient data is time-consuming and does not always support the kind of structured data format that can make systems improve their diagnostic suggestions. Although the functionality provided by the app Diffia has made is the same, the approval process and all the necessary agreements and documents will have to be repeated for each hospital in the region. Once in place, however, the app would be able to communicate with different systems as long as they provide an interface for it to communicate with. As such, the app could potentially help reduce the silo structures in place and improve interoperability and data exchange between systems.

Diffia, however, was not able to test their app with integrations during the time-frame of this thesis. The standards for patient data exchange that came up the most during the case study was openEHR and FHIR. Of the two, FHIR was seen as the better option for most cases and the standard the app by Diffia would use for integrations. Choosing to support one standard over another before Helse Sør-Øst makes a decisive decision on what standards they eventually will support does not
have that many problems. This is due to their middleware service, the lightweight adapter, that can translate between different standards and other formats currently used by IT systems in healthcare. This separation of concerns regarding data exchange standards improves interoperability and helps to future-proof the app since it is able to work with different types of standards without needing upgrades. Instead, the lightweight adapter can be made to support many different standards, and updated when there is a need to support a new way of interfacing.

**Pattern outcome 8**

The empirical pattern outcome for this section is: *Diffia tested their app with Sunnaas and the data from the test shows a reduction in time and complexity of the clinical workflow.*

The findings show that the app by Diffia is tailored to the clinical workflow to such a degree that it is able to significantly reduce both its complexity and time it takes to complete the tasks. The app was only tested as part of the clinical workflow at the stroke ward at Sunnaas. The ward staff that performed the tasks in the test had been made familiar with the app and its use, as well as providing feedback to Diffia that lead to tweaks and improvements. Not all of the staff was as familiar with apps and common usage conventions particular to apps and smartphones. The clinical workflow process that included the use of the app was, on average, superior to the traditional process the staff was well versed in.

**Pattern outcome 9**

The empirical pattern outcome for this section is: *Diffia encountered positive attitudes when they tested their app with Sunnaas Hospital.*

The findings show that the health professionals Diffia tested their app with at Sunnaas Hospital had positive attitudes to the use of the app. The app performed well in the tests and the staff provided Diffia with useful feedback to their particular workflow and how the app performed. They showed positive attitudes to using mobile devices as part of the clinical workflow.
Chapter 6

Discussion

This chapter is all about comparing the expected pattern and the empirical pattern. The pattern matching process forms the foundation for the analytic generalization.

6.1 Pattern matching

This section matches the expected pattern against the empirical pattern. The expected pattern is based on the literature and can be found in Chapter 2, Section 2.2. The empirical pattern is based on the findings from the case study research and can be found in Chapter 4, Section 5.2. This section compares the patterns against each other and each of the pattern outcomes is analyzed in turn. An overview of the comparison can be seen in Table 6.1.

Pattern outcome comparison 1

This section compares the expected pattern outcome *Resources are not deliberately designated for innovation and innovators often only get limited or piecemeal access to those necessary resources* and the empirical pattern outcome *Diffia has not had the resources necessary to enable testing without effectively going through the same processes as a production-ready product available to them.* Table 6.1 has this outcome comparison as matching.

Dougherty and Hardy, [1996] found that innovation projects were not often given access to resources they would need to successfully innovate. Many such innovation projects would simply fail before they had been able to provide the organization with any meaningful change. The authors also found that in the instances when the innovation project did get access to resources it was only available in
CHAPTER 6. DISCUSSION

piecemeal. These resources were not earmarked for innovation directly, but the innovation project was in some instances able to claim some of it over time. One of the major factors the authors found to influence resource availability is the business practice processes. Those organizations that favor existing business practices often does so at the direct cost of innovation.

One of the earliest requests from Diffia was access to a test environment with mock data they could use to test integration. They wanted to get integrations with heavyweight IT electronic health record (EHR) systems tried out as early in the process as possible. This was so that it would be easier for them to present their app to the hospital leadership in a state where the app was more fully featured and integrated, and so it would be easier for the hospital leadership to make an informed decision about acquiring the product. Instead, Diffia did not get access to a test environment with mock patient data. They did, however, collaborate with Medicloud, and a developer from Diffia was sitting at Sykehuspartner were given access to a test environment that were used at Akershus University Hospital (Ahus). The environment was running with sensitive, real-world patient data, which required a slightly different set of agreements then what Diffia had at that moment. This was somewhat due to the complexities of how the different organizations are run, who can access them, and in what form. Thus, the access was revoked while it incident was investigated.

The incident was later resolved and Diffia could set up the necessary agreements with Ahus, mainly the data processor agreement. However, although that would make it possible for a person from Diffia to access the patient data their app would not be. For that to happen the app would need to be certified and approved, as well as needing a few documents on the app that would have to be created by Sykehuspartner. However, only a hospital can order these documents. In order for Diffia to test their app with integration, they would have to try and sell in their app to a hospital in a state that lacked integration. Despite that, it would have made the process easier for everyone involved had Diffia been able to first test their app with integrations in a test environment that had mock patient data.

The outcome from the findings matches with the expected outcome. Dougherty and Hardy, 1996 found that resources were not made available to innovation projects and that the resources that were could be accessed was not designated for innovation. The findings show that the test environments that existed were not set up in a way that benefited innovation, and the access Diffia did get provided only a limited benefit. Bygstad, 2016 states that integration carries with it a large up-front cost, and this was found to be the case for Diffia.
“Sustained Product Innovation in Large, Mature Organizations” was written by Dougherty and Hardy and published in [1996]. The study is about sustained innovation inside large, mature private organizations. While it does not discuss the healthcare industry or innovation from startup companies the expected outcome matches the empirical outcome. The organizational processes and routines regarding making resources available to innovation processes—whether the projects are internal or external—are found to also hold for Helse Sør-Øst and the companies under it.

Pattern outcome comparison 2

This section compares the expected pattern outcome Structures and processes in large, mature organizations sustain routine work and favor existing businesses over innovation and the empirical pattern outcome Diffia has been going against the grain of the current processes and it has involved many stakeholders across organizations. Table 6.1 has this outcome comparison as matching.

Thompson, [1965] found that organizations with a lot of bureaucracy see innovative behavior as unreliable. The author also states that large government organizations feel the need to innovate. This is in conflict with their existing processes, which often strives for productivity through the control of management. A study by Dougherty and Hardy, [1996] also found that large organizations struggle with processes and routines that support innovation, and includes the lack of innovative processes as a part of the business strategy to be one of the key issues.

This thesis has found that the processes in Helse Sør-Øst regarding innovation have been positive, but ultimately not very supportive of IT innovation. These large healthcare organizations have stated that they do want more IT innovation and want to provide processes that support it. All the while, Diffia has continued to work through the current processes that are better suited for the large heavyweight IT system providers than a small startup company.

Both Thompson, [1965] and Dougherty and Hardy, [1996] claims that in order to have innovative organizations, the entire organization needs to support innovation processes on every level. Thompson, [1965] states that creativity is not legitimized in large organizations and that the requirements for innovative areas and the decentralized control of resources makes truly innovative organizations very costly. His paper was published in [1965] while it suggests that organizations have started to have changed their management structures to become more innovative, the research in this thesis have not found that to be the case for IT innovation in Helse
Sør-Øst. Both the study by Thompson, 1965 and Dougherty and Hardy, 1996 discusses product innovation and not IT innovation specifically. They also talk about innovation projects that happen internally in large organizations. However, findings from this thesis show that the organizational processes are just as important for IT innovation, even in the situation where the innovation is driven by a startup company outside of the large organization.

Bygstad, 2016 states that innovation is best served by smaller organizations outside of the large organizations that need it. His article discusses the division of lightweight IT and heavyweight IT in the healthcare context. He claims that large healthcare organizations are better suited to facilitate innovation through heavyweight IT platforms that other, smaller organizations can build upon. Although Diffia is a smaller, more agile organization that wants to innovate clinical workflows with their app, the large healthcare organizations have not been ready to fully support such a collaboration. Diffia has had an uphill struggle against the organizational processes in these large healthcare organizations. They have also met a lot of goodwill and a willingness to try to change the processes to better supportive of the kind of innovation that smaller organizations can provide through lightweight IT. The collaboration with Sunnaas Hospital is a prime example of an attempt to change the existing processes to support more innovation. However, Sunnaas Hospital is also a much smaller organization than Akershus University Hospital (Ahus), where the innovative processes have had more friction with the existing ones.

As such, the outcomes from the expected pattern and the empirical pattern matches. Both outcomes find that existing processes favor existing business over IT innovation. However, Helse Sør-Øst is looking to change that in the future and Sunnaas Hospital has attempted to improve the IT innovation processes through a collaboration with Diffia.

**Pattern outcome comparison 3**

This section compares the expected pattern outcome *IT managers in public organizations are often unable to influence the overall IT strategy* and the empirical pattern outcome *Diffia has needed approval for their product on several internal management levels*. Table 6.1 has this outcome comparison as matching.

Bannister, 2001 found that IT managers in large government organizations are often unable to influence the overall business strategy. Their highest position among the management is often that of middle management and not upper man-
CHAPTER 6. DISCUSSION

agement. As such, their ability to provide long-term solutions are often limited and can only foster such strategies when the internal politics is aligned along the same lines.

This thesis has found that the processes in healthcare do not favor IT innovation. While Diffia has met a lot of goodwill and positive attitudes for their project, including positive test results from a collaboration effort with Sunnaas Hospital, IT management approvals only go so far. Diffia has still had to gain approval on many management levels in several of the healthcare organizations and it is a process that has spanned years.

Some of the issues with the lack of influence IT managers have in the study by Bannister, 2001 can also be found in the studies by Thompson, 1965 and Dougherty and Hardy, 1996. The processes and routines to support IT innovation are not valued in large organizations. Thus, the IT managers are not placed high enough in the management hierarchy to be able to influence the overall business strategy. Instead, Bannister, 2001 states that IT in public organizations are only valued as short-term gain by the politicians currently holding power. The decisions regarding IT comes from the top and from people who might not have any background in IT instead of being fostered by people best suited to manage it.

As such, the outcome from the expected pattern and the empirical pattern matches. The findings from the Diffia case also suggest that the issue is not limited to IT managers. Other management roles, such as those for a department or a clinic level, do also lack the influence to support long-term solutions for better IT innovation processes.

Pattern outcome comparison 4

This section compares the expected pattern outcome Workers not directly involved with innovation often do not know what to do to help or that they could help out and the empirical pattern outcome Diffia have encountered and met with many people that has been dedicated to sharing their experiences with technology and innovation in the healthcare industry. Table 6.1 has this outcome comparison as matching.

Dougherty and Hardy, 1996 found that the workers in an organization that is not directly involved with innovation often do not know how to help. Neither do they know if they could or should help with the innovation processes and routines. The authors found that the innovation process was often invisible in the wider organizational context.
The findings from this thesis show that there are many people in the technology and healthcare industry that want to help with the innovation processes. There are several conferences, HelsIT and eHelse among them, that provide arenas for people interested in the health IT to share their experiences. The talks, discussions, and participants include both health professionals, people in healthcare management, and people involved with the IT industry.

However, many of the people that could benefit directly from an app that improves clinical workflow are not all found participating at these conferences. They are not part of research groups and their normal work routines do not include influencing the strategy for innovative processes in their own organization. The findings from this thesis suggest that most of the health professionals that would be in a position that could benefit from solutions introduced through IT innovation do not have much knowledge about such processes. They are concerned with patient care and not about fostering for innovative tools they do not know about.

As such, the outcome from the expected pattern and the empirical pattern matches. While there are people in the healthcare industry that can and do share their experiences with IT innovation in order to improve the situation, many more do not. This includes the patients that it can be argued has the most to benefit from improved healthcare as a result of IT innovation and better tools for the clinical workflow.

**Pattern outcome comparison 5**

This section compare the expected pattern outcome *Successful innovation happens in self-contained units* and the empirical pattern outcome *Diffia has been working as a self-contained unit and have been able to successfully test their app with Sunnaas Hospital*. Table 6.1 has this outcome comparison as matching.

Bygstad, 2016 claims that innovation is best provided by smaller organizations working together with larger organizations. Separating existing business processes and innovation is also found by Dougherty and Hardy, 1996 to facilitate innovation. Such self-contained units can be easy to support and provides a well-defined area where resources can be allocated to and innovation champions can be fostered.

This study has found that while progress has at times been slow, they have also had some successes. They first aimed to provide their app for Akershus University Hospital (Ahus), but when progress with such a large hospital continued to move slowly they were free to also start a collaboration effort with a smaller
hospital. The testing with Sunnaas Hospital was successful and Diffia was to be flexible with the organizations they collaborated with in large part because of their independent status. As a startup company, they are also completely self-contained and can maximize their efforts around product development and IT innovation in healthcare.

There are some challenges, however. One is that they need to have agreements with the different organizations that would not have been necessary had they been a part of the organization they attempt to provide IT innovation with. Another is that all of the meetings and requests for meetings are that of an external company, though it may be with someone that people in Diffia have worked with before or know as part of their network. The flip-side of the latter challenge is that it can be easier to meet with different decision-makers on different management levels as they are not part of the “chain of command”. Dougherty and Hardy, 1996 also caution against self-contained units for long-term investments. They state that sustained innovation in the long-term requires innovation processes to be incorporated into the entire organization. Thus, it is not completely applicable to the Diffia situation as Diffia, while being a self-contained unit, is also a completely separate organization. The findings from this thesis do suggest, however, that the IT innovation process could benefit from organizations that can adapt their existing routines. One example of this is the collaboration effort with Sunnaas Hospital.

As such, the outcome from the expected pattern and the empirical pattern matches. Self-contained units can support the IT innovation process. It is also found, by both the expected outcome and the empirical outcome, that it is very beneficial if the larger organization can also support innovation through their business processes.

**Pattern outcome comparison 6**

This section compares is about the expected pattern outcome *Successful innovation is closely linked to the efforts of individuals who use their position and network to gain access and resources* and the empirical pattern outcome *Diffia has been able to use its combined network to getting closer and closer to the decision makers*. Table 6.1 has this outcome comparison as matching.

Dougherty and Hardy, 1996 found that successful innovation is linked to individuals. In large organizations that do not do not support innovation processes across their entire business strategy, resourceful individuals with a personal net-
work around them are best suited to innovation. They will often have to use their position and connections in the organization to bargain for necessary resources. The authors found that these individuals often met resistance with the rest of management and keeping the innovation project going in spite of this was challenging and not everyone succeeded. However, these large organizations could foster innovation by championing these individuals and have them mentor newcomers. This would increase the combined experience around innovation over time and empower a growing innovation base in the organization. However, the authors warn that this approach alone is not the most effective for sustained innovation in the long-term. In an older study, Thompson, 1965, the author claims that “conceptualization of power must extend beyond the personal and encompass the organizational”. Another suggestion was to make seed money available for innovation projects throughout the organization. Diffia experienced a few times that there was an uncertainty of which group or department in the healthcare organizations that should budget a cost, such as the ROS (risk and vulnerability) analysis for the app.

This thesis has found that the personal networks and connections of the Diffia members have benefited their innovation efforts. It has helped opening doors and enabled them to sit down with decision-makers previously unavailable. Sometimes people in their network have been promoted into decision-maker positions, which has made further connections possible.

As such, the outcome from the expected pattern and the outcome from the empirical pattern matches. Dougherty and Hardy, 1996 discusses individuals that are part of the organization that wants innovation, however, this thesis has found it to hold for Diffia and healthcare organizations as well.

Pattern outcome comparison 7

This section compares the expected pattern outcome Patient data is managed with a silo mentality and the empirical pattern outcome The IT systems used in the Helse Sør-Øst region is managed with a silo mentality. Table 6.1 has this outcome comparison as matching.

Omachonu and Einspruch, 2010 has found the silo mentality to be prevalent in healthcare. One example they give for it is when a patient record in one hospital cannot be accessed by the electronic health record (EHR) system in another hospital. Bannister, 2001 describes the heart of the problem to be a combination of unintegrated, often legacy systems. These are often made in isolation and not
updated. Many of these systems are unique and custom built. They may also become obsolete or redundant due to changes in politics or other organizational changes. The author claims silo systems are inefficient, and Bygstad, 2016 states that they tend to scale poorly.

This thesis has not been able to fully study the silo systems in Helse Sør-Øst. Due to time constraints, Diffia was not able to get access to a test environment where they could test integrations with EHR systems. However, the main founders of Diffia have both worked as health professionals and have personal experience with the systems and the prevalent silo mentality. Based on their experience and that of others in Diffia with similar experiences from another large government organization (the Norwegian Public Roads Administration) they could make some plans for integration and interoperability between systems.

The heavyweight IT systems running in the hospitals in the south-eastern healthcare region of Norway do not all exchange data with the same format. This was known to Diffia and their proposed solution was to introduce a lightweight adapter service that would sit between their app and the other systems and translate one data exchange standard to the others. This middleware service would be responsible for all of the complexities of the different standards and be responsible for taking care of it seamlessly. As a side benefit, this solution would make it possible for others to provide IT innovation solutions without having to also handle the data exchange complexities on their own.

This way of thinking is in line with Bygstad, 2016, who states that should be a means to reach the goal and not the aim of it. However, there are other studies on interoperability and data exchange standards in healthcare. Lamprinakos et al., 2014 and Bender and Sartipi, 2013 claim that data exchange standardization is a crucial part of being able to provide the best possible healthcare. They both put forth the FHIR (Fast Healthcare Interoperability Resources) standard by the HL7 group as the best candidate. It is built upon existing, tried and true Internet standards for data exchange and both studies describe FHIR to be well suited for mobile environments, such as smartphones and tablets.

Diffia has chosen to support the FHIR standard with their app. An illustration of the app together with the lightweight adapter can be seen in Figure 6.1. However, due to the lightweight adapter service, the actual standard it uses for data exchange does not matter as much. Such middleware solutions are not new. A paper by Bernstein, 1996 discusses the topic in depth. The author describes a middleware service as “a program on one system can access programs and data on another system”. It is well suited for situations that involve legacy systems
and allows application developers to focus on delivering functionality instead of dealing with data exchange complexity. Mobile computing and multimedia are two of the areas the author mentions that will be a strong driver for middleware services, though the paper was published in 1996.

Figure 6.1: A simplified illustration of how the lightweight adapter would be able to interface with the heavyweight IT systems

As such, the outcome from the expected pattern and the outcome from the empirical pattern matches. The silo mentality is prevalent in both cases. However, Helse Sør-Øst is attempting to move away from it. Through their Digital Renewal program, they propose changes to reduce the number of heavyweight IT systems (and different versions of the same systems) they are managing in their hospitals. This is illustrated in Figure 5.1 and Figure 5.2.

Pattern outcome comparison 8

This section compares the expected pattern outcome IT systems in the healthcare industry fit so badly with the clinical workflow that health professionals often end inventing time-consuming work-around routines to deal with them and the empirical pattern outcome Diffia tested their app with Sunnaas and the data from the test shows a reduction in time and complexity of the clinical workflow. Table 6.1 has this outcome comparison as not matching.
Lium et al., 2008 found that despite introducing heavyweight IT systems the same, paper-based, routines prevailed. The authors state that new routines have to be established when introducing new IT systems, and that the paper legacy slows down the pace of organizational changes. A study by Ellingsen and Monteiro, 2017 found that making health professionals more productive the IT systems dictated their workflow. As a response to this limiting of their actions, the health professionals start to invent additional, often time-consuming workaround routines. They describe the one-size-fits-all model as a big part of the problem. The systems are made so generic that they do not support specific workflows and end up reducing effective workflows.

This thesis has found this is not always the case. When Diffia tested their app with Sunnaas Hospital the use of the app during the clinical workflow reduced both complexity and the time to perform the tasks. The app is lightweight in use and can be carried with the health professionals as they go about their tasks. As such, it is a tool that is tailored to the workflow instead of dictating it.

As such, the outcome from the expected pattern and the outcome from the empirical pattern do not match. One of the main reasons can be attributed to the type of systems used in the clinical workflow. Both Lium et al., 2008 and Ellingsen and Monteiro, 2017 discuss the use of heavyweight IT systems, while the app by Diffia is a lightweight IT system. The outcome does not hold, and it the literature suggests that this difference in lightweight and heavyweight is the cause. Bygstad, 2016 states that supporting a specific workflow is a typical use case for lightweight IT, and that it is based on a culture of innovation and experimentation.

**Pattern outcome comparison 9**

This section compares the expected pattern outcome *Health professionals have largely positive attitudes towards the use of smartphones as part of the clinical workflow and the possibility of greater reliance on them in the future* and the empirical pattern outcome *Diffia encountered positive attitudes when they tested their app with Sunnaas Hospital*. Table 6.1 has this outcome comparison as matching.

Koehler et al., 2013 found that health professionals were positive about the use of smartphones during the clinical workflow. There were some concerns by the health professionals regarding cross-infection and potential patient confidentiality breaches, however, the authors suggested that the smartphones could be treated with a disinfectant like other clinical tools. The use of smartphones is also highlighted as a potential key resource for the clinical workflow.
This thesis found that the app Diffia tested with Sunnaas Hospital was received well by the participants. The workflow that used the app reduced both complexity and the time to complete the tasks. The app by Diffia is, however, aimed to be integrated with the electronic health record (EHR) system at the hospitals, while the apps in the Koehler et al., 2013 study were mostly medical apps. The security issue raised in the study is important to cover. The authors suggest that software could be installed that would erase any potential patient data on it in the event of loss or theft. Additionally, Diffia would run their app on the secure network in the hospital with the same authorization as is used for existing EHR systems.

As such, the outcome from the expected pattern and the outcome from the empirical pattern matches. Boukerche and Ren, 2009 states that mobile healthcare can boost diagnosis and patient care by making patient information available to health professionals “at any place and at any time”.

6.2 Analytic generalization

Yin, 2013, Kindle Locations 1071-1076 states that case studies are “generalizable to theoretical propositions” and that the goal is to arrive at an analytic generalization, which is to expand and generalize theories. The research literature is used as the basis for this theory, and it is the findings from this thesis that will expand it.

This section summarizes the contents of the pattern matching process and presents the analytic generalization. The expected pattern is grounded in the research literature and the empirical pattern is grounded in the findings. Each outcome in the two patterns was compared in Section 6.1 of this chapter, and for each of the outcomes it was discussed how the findings either supported or challenged the theory.

Pattern matching summary

The internal validity of the case study research is stronger when the pattern matches. This subsection summarizes the comparisons between the pattern outcomes.

Eight out of nine outcomes were found to match, with one outcome challenging the theory. Table 6.1 displays the outcomes side by side. To sum up, (1) resources were not made available to innovation projects, (2) processes favoured existing businesses over innovation, (3) IT managers and other management roles is often unable to influence overall strategy for innovation, (4) there are health professionals who share their experiences but most do not know how to help with
innovation processes in their own organization, (5) successful innovation can happen in self-contained units, (6) successful innovation can be linked to individuals who use their position and connections to further the innovation goal, (7) Patient data is often managed with a silo mentality, though Helse Sør-Øst wants to change that in their region, (8) the findings challenged the theory and showed that an IT system can reduce time and complexity of the clinical workflow instead of creating time-consuming work-around routines, and (9) health professionals have positive attitudes towards using smartphones during the clinical workflow.

Pattern outcome 8 was the only one where the findings challenged the theory. However, the research literature offers some insights into why this was. The expected pattern outcome was *IT systems in the healthcare industry fit so badly with the clinical workflow that health professionals often end inventing time-consuming work-around routines to deal with them*, and the empirical pattern outcome that challenged it was *Diffia tested their app with Sunnaas and the data from the test shows a reduction in time and complexity of the clinical workflow*. Bygstad, [2016](#) uses the concepts *lightweight IT* and *heavyweight IT* to describe a categorical division between IT systems, including those used in healthcare. These are ideal types, though lightweight IT usually denotes systems on mobile devices and a culture of innovation, while heavyweight IT usually denotes back-office systems. An example of the first is the app made by Diffia and an example of the latter is electronic health record (EHR) systems, such as DIPS.

The studies by Lium et al., [2008](#) and Ellingsen and Monteiro, [2017](#) describes heavyweight IT systems that are used during the clinical workflow. These studies found that these systems would often require the health professionals to use them in a way that limited their actions. This, in turn, would result in time-consuming work-around routines created by the health professionals to deal with these systems during the clinical workflow. The app by Diffia, however, falls into the lightweight IT category. Bygstad, [2016](#) states that a typical use case for lightweight IT is apps that support specific workflows or provide simple pieces of information. The app is running on a smartphone that can be carried with the health professionals as they perform the tasks required by the clinical workflow. It is the health professionals themselves who dictates how they want to use the app and how much they choose to rely on it. The app supplements the clinical workflow instead of dictating it, and it does not replace existing systems for those that prefers to only work with the heavyweight IT systems.
Research questions

There are several ways in which the findings expands on the research literature. Some of that has already been discussed in Section 6.1 of this chapter, where the expected and empirical patterns were matched and each of the outcomes was compared one by one. This subsection looks at the analytic generalization in the context of the research questions.

The first research question is as follows: **How can a startup company that is creating an app for use in the clinical workflow contribute to IT innovation in hospitals?**

A startup company is a self-contained unit with flexible processes and individuals that can be mentored into innovation champions (Dougherty and Hardy, 1996). Resources are not always available to innovation projects but the findings from this thesis show that a startup company is flexible enough to approach innovation from different angles. A smaller hospital, such as Sunnaas, can be approached for testing when larger hospitals with slower, more bureaucratic processes, such as Akershus University Hospital (Ahus), takes a long time. Apps and lightweight IT has been shown as a strong candidate for the innovation process (Bygstad, 2016). However, due to the lack of access to necessary resources, such as a test environment with mock patient data, the integration effort has been costly. Additionally, this cost has had to been paid up-front. The current system requires a new product to go through all of the same processes and certifications as a fully production-ready app, just to be able to test integration. When such integration is in place, it will likely have to go through much of the same process again. The lack of insight into necessary agreements and documents can be high-risk for new actors wanting to innovate in the healthcare industry. Patient data are sensitive and the process for handling them should be clear for both parties before any potential incidents. Both in terms of the hospitals being in full control over the data and that the collaborators involved can avoid causing an incident that could damage the trust between the parties.

The processes that Diffia has gone through has helped to shed a light on the challenges with how the existing processes for innovation currently are. The processes strongly favor existing businesses and products that already has all of the necessary agreements, certifications, and documents. There is, however, a lot of goodwill among health professionals and managers in the healthcare industry. They are not always in a position to influence the overall business strategy and is in many cases unable to foster IT innovation. However, sometimes a connection
from the network Diffia has is promoted into a position where he or she can set up a meeting with a decision-maker in a better position to influence the overall strategy.

One aspect that can be particularly challenging for small companies developing lightweight IT solutions has to do with the way the product is developed. A larger firm is able to develop a fully featured IT system and is able to absorb the cost of waiting a few years for the processes to catch up and deploy it to the production environment and be used by the health professionals. Small startup companies often do not have that option. Diffia aims to create a tool that is tailored to the clinical workflow. They develop using user-centered methodologies and they want to test it with users and get their feedback as part of the development process. The processes for acquiring systems at the hospitals are not designed with this in mind. Since there is no single point of contact for innovation processes at the hospitals, it is challenging to create something together with the healthcare industry. The lack of such a group means that any sort of technological development collaboration has to be made explicitly with each and every hospital, who themselves have different processes for dealing with innovation.

The lack of a test environment also influences how well a startup company and a hospital collaborate on developing a product together. Diffia and Sunnaas were able to test the app together. The results were good. However, the value of the app and its use in the clinical workflow could only be partially tested due to the lack of a test environment and integration options. Diffia was unable to fully demonstrate the value of their product to Sunnaas, and Sunnaas could not make fully informed decisions about the product. Sunnaas was aware of the issues with the test environment and the lack of integrations, but they were unable to influence the technological aspect of the innovation process. They were very enthusiastic, however, and was able to influence the human resources necessary and could provide health professionals to test the app, as well as a hospital setting to test it in. As such, while healthcare managers influencing the IT aspect of the innovation processes, they are can be in a position to aid the process by making personnel available.

The second research question is as follows: *How can an app influence the clinical workflow for health professionals?*

Apps are a form of lightweight IT (Bygstad, 2016) and the app by Diffia was found to be well suited for the clinical workflow. Results from collaboration and testing with Sunnaas Hospital showed that when health professionals used the app during the clinical workflow it reduced both complexity and the time to perform
the tasks. It had a positive effect on the clinical workflow and health professionals were positive about its use. The main challenge and difference between the expected pattern and the empirical pattern were the use of IT systems and the potential work-around routines that are created for them. The research literature was only considering heavyweight IT systems, however, and many of the routines was not changed sufficiently to accommodate them (Ellingsen and Monteiro, 2017; Lium et al., 2008). This often resulted in health professionals inventing ways around the limitations such systems dictated for the clinical workflow. The app by Diffia was instead a tool that the health professionals could bring with them and use like any other clinical tool at their disposal. The app did not limit their actions, but opened up more options to effectively perform their tasks. The differences in lightweight IT and heavyweight IT can explain the differences in the work-around routines created or not created by the health professionals. As such, the findings suggest that lightweight IT apps can have a positive influence on the clinical workflow, and that health professionals show positive attitudes to the use of smartphones.

The third, and final, research question is as follows: How can an app interface and exchange patient data with existing IT systems in the hospitals?.

Helse Sør-Øst (South-Eastern Norway regional health authority) manages patient data with a silo mentality, which is a common approach for healthcare (Omachonu and Einspruch, 2010). Silo systems are inefficient and often consists of combination of unintegrated, legacy systems (Bannister, 2001) that scale poorly (Bygstad, 2016). Helse Sør-Øst has a program for Digital Renewal and wants to move away from this kind of silo system mentality. Patient data exchange is key instead, and the findings show that the app by Diffia can be a part of this move to systems with more interoperability. The app itself will use the FHIR standard (from HL7) for patient data exchange, which is recommended by the research literature (Bender and Sartipi, 2013; Lamprinakos et al., 2014). The real benefit towards more interoperability is a companion middleware service. This lightweight adapter can be deployed in the secure zone and translate between different data exchange standards. Being a separate service also means that any other IT system also in the secure zone can use it to increase interoperability. As such, the app can use industry standards for patient data exchange and rely on a separate service to handle interoperability with systems that do not support the same standard.
Transferability to other cases

The internal validity of the case is strong. The expected pattern and empirical pattern matches for all outcomes, except for number 8. This outcome is about who some IT systems in healthcare make health professionals create work-around routines. The research literature states that the IT systems do, while the findings from this case show that the app by Diffia reduced time and complexity in the clinical workflow. This can, however, be explained by the research literature (Bygstad, 2016) concerning lightweight IT and heavyweight IT. Lightweight IT, including apps, are a prime candidate for specific workflows. Heavyweight IT, such as electronic health record (EHR) systems, are better suited for platforms that innovative lightweight IT systems can extend. The app by Diffia is part of lightweight IT while the systems described in the research literature are heavyweight IT systems. As such, the patterns match and the case has a strong internal validity.

The findings from this case help to extend the existing theory and projections can be made for other cases. Self-contained units, such as startups, is able to IT innovation for the healthcare industry and improve the clinical workflow. It may require individuals with large personal networks and the perseverance to struggle against existing business processes that are not designed to support innovation. Such IT innovation would benefit from lightweight IT, and apps tailored to the clinical workflow are met with positive attitudes from health professionals. Interoperability can be a limiting factor, but is not one that necessarily stops the innovation process in its tracks. It can slow it down, however, and it is important to note that much-needed resources might be scarce. Individuals may end up in positions where they have to bargain for it or gain access through key people in their network. Unfortunately, this is a situation that may not improve much, as IT managers always hold positions high enough in the management to be able to influence overall business strategy and foster innovation processes. Nor do many other workers know enough about the innovation processes to help. However, they are not invisible to everyone in healthcare, where several conferences are held yearly to provide an arena for health professionals and others in the field who wants so share their experiences.

Some of the research literature is in the context of the healthcare industry, while some of it has a broader, more general context. It is possible that the studies on innovation processes outside of healthcare are not applicable due to some particularity. However, these studies look at the innovation processes from the context of large, often mature, organization. The findings from this thesis show
that Helse Sør-Øst and both Akershus University Hospital (Ahus) and Sykehus-partner are large organizations with heavy bureaucratic processes. They fit the mold presented by the literature. Sunnaas, on the other hand, is a smaller organization. Based on the outcomes from the pattern matching, the size can explain how they were able to better adopt some of their processes to support the innovation. They were unable to influence the technological aspects, but could provide resources in the form of personnel.

Another potential critique is the age of some of the research literature. The study by Thompson was published in 1965. However, the findings there is backed by more recent studies included in the expected pattern. There is a sentiment among health professionals, shared on numerous occasions at both the HelsIT and eHelse conferences, that “nothing” has happened with IT in healthcare since before the World Wide Web became a consumer service. These sentiments are echoes of the different outcomes in both the expected pattern and the empirical pattern. The main aspects hold and can be used as the basis for other cases and future work.
## Expected pattern outcome

<table>
<thead>
<tr>
<th>#</th>
<th>Expected pattern outcome</th>
<th>Empirical pattern outcome</th>
<th>Matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Resources are often unavailable to innovation</td>
<td>Diffia did not have necessary resources available</td>
<td>Matching</td>
</tr>
<tr>
<td>2</td>
<td>Processes favor existing businesses over innovation</td>
<td>Diffia has had an uphill struggle against the processes</td>
<td>Matching</td>
</tr>
<tr>
<td>3</td>
<td>IT managers do not influence overall IT strategy</td>
<td>Diffia has needed approval on several management levels</td>
<td>Matching</td>
</tr>
<tr>
<td>4</td>
<td>Workers do not know how to help innovation</td>
<td>Diffia has met many who sharing their experiences with other</td>
<td>Matching</td>
</tr>
<tr>
<td>5</td>
<td>Successful innovation happens in self-contained units</td>
<td>Diffia has worked as a self-contained unit with some success</td>
<td>Matching</td>
</tr>
<tr>
<td>6</td>
<td>Successful innovation is linked individuals and their network</td>
<td>Diffia has used its network to getting meetings with decision-makers</td>
<td>Matching</td>
</tr>
<tr>
<td>7</td>
<td>Patient data is managed with a silo mentality</td>
<td>The IT systems used in the Helse Sør-Øst region is managed with a silo mentality</td>
<td>Matching</td>
</tr>
<tr>
<td>8</td>
<td>IT systems in healthcare results in time-consuming work-around routines</td>
<td>Diffia and their app reduced time and complexity during the clinical workflow</td>
<td>Not matching</td>
</tr>
<tr>
<td>9</td>
<td>Health professionals have positive attitudes towards the use of smartphones</td>
<td>Diffia encountered positive attitudes toward the use of their app</td>
<td>Matching</td>
</tr>
</tbody>
</table>

Table 6.1: An overview of the matching of the expected pattern and the empirical pattern
Chapter 7

Conclusion

This thesis contains research about IT innovation processes in Norwegian healthcare. It follows a startup company called Diffia and the processes they have encountered when attempting to introduce an innovative digital tool for the clinical workflow. The target hospitals were Akershus University Hospital (Ahus) and Sunnaas Hospital in Helse Sør-Øst (South-Eastern Norway regional health authority). The innovation processes in healthcare proved to be very slow, however, and time constraints limited the duration of the study. The research was not able to follow the startup for the whole process (which is still ongoing as of May 2017 and could be said to have started in 2015), though it was able to cover a collaborative testing effort between Diffia and Sunnaas. They tested the app by Diffia with health professionals in a hospital setting at the stroke ward of Sunnaas.

The research questions for this thesis is as follows: (1) How can a startup company that is creating an app for use in the clinical workflow contribute to IT innovation in hospitals? (2) How will this app affect the health professionals using it and their clinical workflow? and (3) How will this app interface and exchange patient data with existing IT systems?

The expected pattern from the research literature matches very well with the empirical pattern based on the findings. There was a mismatch regarding workaround routines, however, but the difference can be explained by the literature. The end result is that theory holds for this case and that startup companies can be an important part of IT innovation in healthcare. They are self-contained and flexible enough to adapt to changes in their environment. Lightweight IT systems, such as apps, can improve clinical workflows and provide support mechanisms for interoperability between different IT systems running at the hospitals. The processes in healthcare are not, however, designed with innovation in mind. Per-
severance is often needed and it helps to have a network to lean in order to set up meetings with decision-makers. Necessary resources that would help the innovation process is not always available either. However, the community around innovation in healthcare is strong and vocal about sharing their experiences.

**Future work**

One of the main aspects of future work would be to follow the entire process from start to fully integrated app in use by health professionals in a real-world setting. I was not able to follow this case as far due to time constraints. It would also be of interest to follow a different startup that themselves followed the same steps that Diffia did and find out if the processes supporting innovation had gotten any better. Another aspect that could be provide interesting research would be a comparison of how well different lightweight IT and heavyweight IT systems perform in the clinical workflow.
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