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Agile IT Infrastructure Transformation

A Case Study of a Nordic Incumbent Telco

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Agil IT Infrastrukturs-Transformation

En fallstudie av ett nordiskt telekombolag

av

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Abstract

In a growing digital economy, where demands for network services and competition from various communication-over-the-network service providers intensify, telecommunication companies need to keep up in an ever-changing environment. As there is a need to reduce time-to-market for new network services, agility becomes restrained by having to operate within large legacy IT infrastructure environments.

While agile methodologies in modern time have attained recognition in the field of software development for the way they help to manage changing customer demands and deliver early value in continuous increments, it is yet uncertain how agile methodologies can best be adopted for IT infrastructure deliveries to achieve the same purpose. Hence, this study explores how legacy IT infrastructure can be transformed in an agile way into modernized infrastructure landscapes supporting the business with fast enough development, release and deployment of new network services in demand. More precisely, the study investigates how larger IT infrastructure transformation projects can be executed by the help of agile practices.

In order to investigate this, the study carries out a case study at Telia Company, a large Nordic incumbent telecommunications company possessing a big legacy of IT infrastructure. The study conducts internal interviews with Telia employees as well as external interviews with agile experts. Also, benchmarking is conducted with a well-established Swedish bank to better understand the challenges and how agile practices can best be applied.

The study concludes that agile practices influenced by agile frameworks Scrum and Kanban can advantageously be applied at team level for more agile execution. However, the surrounding organizational business landscape greatly sets the limits for agile deliveries, due to dependencies on cooperation from the business side in the execution phase and the need to be aligned with business needs and stakeholder requirements.

Further, the study also shows that the application of agile practices at team level in combination with a close dialogue with stakeholders and a scaled agile approach requiring investing in automation, is the key for more agile infrastructure deliveries. In this way, aligned end-to-end delivery processes can be better developed and infrastructure needs better understood and implemented at the right time. As a contribution, the study proposes a model with inspiration from agile frameworks Scrum, Kanban and SAFe, for how this may work in practice.

Key-words

Agile, Agile methodologies, Scrum, Kanban, SAFe, Project management, IT infrastructure transformation, IT infrastructure, Telecom

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Sammanfattning

I en växande digital ekonomi, kännetecknad av intensifierad efterfrågan på nätverkstjänster och konkurrens från diverse aktörer som erbjuder kommunikationstjänster över nätverket, behöver telekommunikationsföretag hålla uppe takten i den snabbföränderliga omgivningen. Samtidigt som det finns behov av att minska tid till marknad för nätverkstjänster, blir snabbheten återhållsam på grund av att man måste jobba i miljöer med stora IT infrastrukturs-arv.

Agila metoder har i modern tid blivit erkända inom mjukvaruutveckling för hur de hjälper att hantera föränderliga kundbehov och kontinuerligt leverera tidigt värde inkrementellt. Dock råder det fortfarande ovisshet kring hur agila metoder kan tillämpas bäst inom IT infrastrukturs-leveranser för att uppnå samma ändamål. Följaktligen utforskar denna studie hur IT infrastrukturs-arv agilt kan bli transformerade till moderniserade infrastrukturs-landskap som stödjer verksamheten med tillräckligt snabb utveckling, lansering och spridning av efterfrågade nätverkstjänster. Mer exakt undersöker studien hur större IT infrastrukturs-projekt kan bli genomförda med hjälp av agila arbetssätt efter en initial projektplanering.

För att undersöka detta genomförs en fallstudie på Telia Company, som är ett etablerat nordiskt telekommunikationsföretag och som har ett stort arv av IT-infrastruktur. Studien inkluderar interna intervjuer med Telia anställda såväl som externa intervjuer med agila experter. Även en benchmark-undersökning med en väletablerad svensk bank utförs för att bättre förstå utmaningarna och hur agila arbetssätt kan bli tillämpade på bästa sätt.

Studien drar slutsatsen att agila arbetssätt med influens av de agila ramverken Scrum och Kanban med fördel kan bli tillämpade på team-nivå för mer agila verkställanden. Dock begränsas agila leveranser till stor del av det omgivande verksamhetslandskapet. Detta på grund av beroenden av

samarbeten från verksamheten i olika utförande-moment och behovet av att vara sammanvävd med verksamhetsbehov och intressentkrav i leveranserna.

Sammanfattningsvis menar studien att tillämpningen av agila arbetssätt på team-nivå i kombination med en nära dialog med intressenter samt ett initiativ för att skala agilt, är nyckeln för mer agila infrastrukturs-leveranser. För att uppnå detta, krävs även investering inom automation. På så vis kan end-to-end-strukturerade leveransprocesser bli bättre utvecklade och infrastrukturs-behov bättre förstådda och implementerade i rätt tid. Som ett bidrag föreslår studien en modell för hur detta kan fungera i praktiken, med inspiration från de agila ramverken Scrum, Kanban och SAFe.

Nyckelord

Agil, Agila metoder, Scrum, Kanban, SAFe, Projektledning, IT infrastruktur transformation, IT infrastruktur, Telekom

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Stockholm, June 2018
Tasmiah Akhter and Tobias Åkerlind

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1 Introduction

This chapter includes a background which introduces the reader to the context which makes the study relevant. This is followed by a problematization, the purpose of the study, the research questions, delimitations and expected contribution of the study. Thereafter, a description of the commissioner company and the unit at which the study is carried out is given, along with a basic description of transformation projects, in order to facilitate understanding for the reader. Lastly, the disposition of the study is explained.

1.1 Background

In a growing digital economy characterized by increasing and changing consumer demands for network services, technological development and high increase in data traffic (Finnegan, 2016), telcos (telecommunications companies) face severe challenges as digitization changes the industry landscape. In a 2015 cross-industry survey of industry leaders, the telecom sector is found in second place out of sectors expecting moderate or massive digital disruption in the near future. Traditional voice and messaging businesses shrink as alternative communication channels grow in usage (Caylar & Ménard, 2016). In a dynamic, ever-changing environment which is furthermore characterized by complexity and uncertainty of factors (Orlowski et al., 2017), new network services need to be continuously deployed as old services are used less. Furthermore, non-traditional over-the-top players, such as Facebook, put high pressure on telcos' revenue streams as they transform business models and provide with new communication services over the network (Dell EMC & VMware, 2016). In comparison to newly-born, modern and nimble companies, traditional telcos might be strapped for resources necessary to provide efficiently with network services in demand due to restraint of having to operate within large legacy IT infrastructure systems. Thus, to stay competitive, reduce time to market, attract new customers and retain existing customers, telcos need to provide with reliable network services while modernizing legacy IT infrastructure into infrastructure which enables greater flexibility, agility, scale and operating cost efficiency (Dell EMC & VMware, 2016). In this transition, cloud computing and virtualization are key technology priorities for telcos today (Jose & Kumar, 2015).

So, what is IT infrastructure then? IT infrastructure is the setup of shared technical components and IT services necessary for the existence, operation and management of the organization's IT environment. This includes hardware, networks, data and software applications, which are commonly deployed within the organization's data centers. Apart from containing physical assets such as hardware platforms, data repositories and other networking and object-based technologies, it also includes the quality and updating frequency of IT-related assets. The IT infrastructure can be seen as a major business resource and is crucial for the firm's competitive advantage as it is the pillar which enables cross-functional initiatives and processes for the rest of the business. By doing so, it serves as the backbone which enables fast development and releasing of services and products in demand by external end customers, as well as assuring the operational compatibility for them. The combination of strong human IT skills and, as mentioned, a flexible IT infrastructure, has great influence over the capability of the organization (Akbar et al., 2015).

In order to realize the gains with a more modern infrastructure, the transformation needs to happen fast (Towster, 2016). Meanwhile, it has been reported that telco IT transformation programs are not shifting fast enough. The challenges seem similar at all companies possessing a legacy of old infrastructure. Whatever it is the organizations are doing in a transformation project, they are most likely affecting the current operating environment. The IT systems which the organizations are making changes for are serving customers and markets and it is therefore important to know how any changes affect the business applications. The outspoken challenge is to deliver transformation projects faster than today. The perception is that it should be possible to deliver and establish infrastructure services faster than what is the case today (Telia Company, 2018).

The term "agile" involves the sets of methodologies and practices that have emerged throughout the last couple of decades in order to increase relevance, quality, flexibility and business value of software solutions. This evolution is a result of addressing the traditional problems seen in software development and service delivery activities in the IT sector, such as budget overruns, unmet deadlines, low quality on outputs and dissatisfied users (Cooke, 2012). Agile project management methods have revolutionized the way software projects are organized and executed. Nowadays, agile methodology is a widely accepted approach of developing software, even so in the telco sector. While the methods have their origins in software projects, they have gained increased attention in the general project management field (Stettina & Hörz, 2015). This can be explained by a recognition that traditional models for planning and execution might not be optimal or calibrated for the specific challenges being inherent in projects (Serrador & Pinto, 2015). There are many success stories about companies who have transitioned to agile ways of working (Gren et al., 2014). While agile ways of working is still mainly an IT phenomenon (Serrador & Pinto, 2015) with current methods tied to small, co-located software projects and individual teams (Stettina & Hörz, 2015), large-scale empirical studies of projects across multiple industries and countries have shown that agile use have a positive impact on project success. More specifically, by increased efficiency and overall stakeholder satisfaction with regards to organizational goals (Serrador & Pinto, 2015). This gives reason to believe that agile ways of working can be adopted for projects with a characteristic nature distinct from that of software development projects. As telcos have realized the need to become more agile (A.T. Kearney, 2014), it has been recognized that their success will be determined by their ability to scale agile and extend their capabilities in agile software development to all functions and business units within the organization (Comella-Dorda et al., 2016). However, the area seems not been fully studied as only limited research can been found regarding the context of agile and IT infrastructure.

1.2 Problematization

As telcos need to become more agile in their development of existing and new network services in an ever-changing environment, there is a need to realize an agile IT infrastructure environment which supports this. As new applications, features and IT system functionalities are developed, the operative requirements furthermore need to be in place to support them. Thus, the challenge is to modernize legacy IT infrastructure in an agile way in order to enable the business to provide with the network services in demand, yet controlling the costs and keeping service quality on level. While there is adequate research about how agile work methods fit into the context of software

development projects, there is limited research about how legacy IT infrastructure can be modernized in an agile way.

1.3 Purpose

The purpose of this study is to investigate how IT infrastructure transformation projects can be executed in an agile way at telcos. The aim is furthermore to propose a model for this.

1.4 Research Questions

In order to address the purpose of the study, two research questions are formulated as followed:

RQ1: What are the challenges telcos are facing in the execution of IT infrastructure transformation projects?

RQ2: How can agile ways of working help to cope with the challenges and facilitate for execution of IT infrastructure projects in an agile way at telcos?

1.5 Delimitations

In order to make the problem researchable and carry out a feasible study in the time span of 20 weeks set for a master's thesis, delimitations needed to be made. The study is delimited to a case study at Telia Company in order to understand the challenges and possibilities of agile execution of IT infrastructure transformation projects at telcos. As the study investigates how projects may be executed, the study is delimited to looking at a process-and production perspective within the organization, thereby delimited from looking at the effects of the telco industry as a whole. More specifically, the process-and production perspective of the IT Infrastructure Transformation unit. To some extent, other units' processes as well, in the cases where IT Infra's processes' feasibility are related to these. Also, to some extent, the study furthermore includes the perspective of individuals when this relates to the outcome of processes. Moreover, the study is delimited to the execution phase of IT infrastructure transformation projects, meaning that the study does not investigate how projects are picked, defined and how the initial planning phase looks like. In addition to the agile values and principles, the study is furthermore delimited to the number of theoretical agile frameworks chosen to be considered in the analysis, namely Scrum, Kanban and SAFe.

1.6 Expected Contribution

The study aims to contribute to practical knowledge for telcos facing challenges in their IT infrastructure transformation journeys, by proposing suitable agile ways of working in order to succeed with successful transformations.

Through an academic perspective, the study aims to contribute with insights about challenges and corresponding agile ways of working appropriately for the context of IT infrastructure transformation, an area which is lacking in research. As the study aims to result in a model for this, the model may be examined and discussed in future research.

1.7 Commissioner

Here we present information about the case company such as service offerings and geographic location of operational business. Furthermore, we present information about the unit at which the study is carried out, the unit's service offerings and the relevant surrounding organizational structure with regards to the unit's work. Lastly, some of the projects which are included in the investigation, are briefly described.

Telia Company is a large Nordic telco incumbent with approximately 20 000 employees and 500 000 shareholders, aiming to become the next generation telco. The company is listed at Nasdaq Stockholm and Nasdaq Helsingfors. They sell connectivity and network services for fixed telephony, data communication, internet, digital TV, IP telephony and mobile telephony to private consumers, businesses and organizations. They are currently operating in the Nordics, Baltics and Eurasia. The company has an outspoken goal to become more agile. There is a basic agile model for projects within the organization to follow, which has more frequent planning and execution cycles. However, it is up to specific departments, units and projects how to best realize agile ways of working with regards to their contexts (Telia Company, 2018).

The thesis is carried out at the Global Services and Operations IT Infrastructure department, which is responsible for driving the strategy, architecture and development of the organization's IT infrastructure platforms and services. The department owns and drives the transformation agenda towards an automated cloud environment. The department offers data center services to the organization's internal customers within application operation, solution design, cloud, compute and database services along with other additional services (ibid).

Organizational Structure Relevant for IT Infrastructure Transformation Projects

With regards to IT infrastructure transformation projects, typically lasting for longer than a year, many parts of the divided organization are involved in different ways. In Figure 1, a simplified map of the relevant organizational structure with regards to the projects is illustrated. A project team may consist of roles such as project management, business owner, technical groups and technical resources. Project management drives the agenda of the projects, communicating and coordinating with different stakeholders throughout the project. The technical teams perform the actual technical infrastructure realizations of the project, coordinated by project management and/or technical project management. This includes setting up the new infrastructure environment with the right equipment, such as hardware and software, as well as making systems compatible with the new environment and migrating them. When building a new environment, it is common that third-party suppliers of equipment are part of the project (ibid).

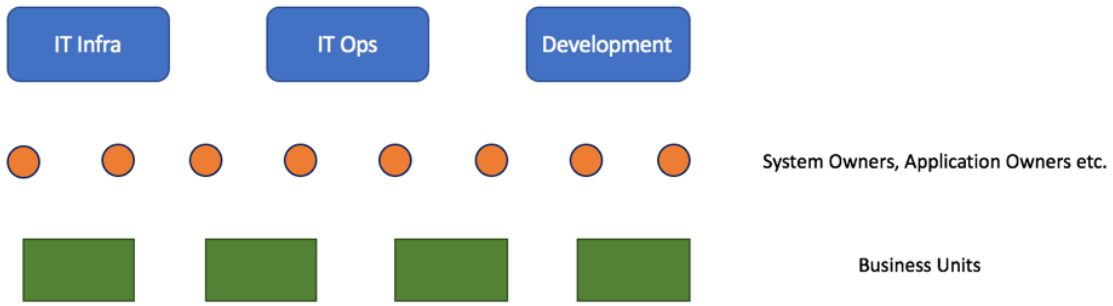

Figure 1. Brief overview of the organizational structure relevant for IT infrastructure projects at Telia Company.

Throughout the organization, there are business units who utilize the organization's applications in order to generate business for the company. They are interacting with end customers. These business units may order infrastructure services from the IT Infra department, and may thereby be customers within the projects. To exemplify this, it may be the case that a business unit sending IPTV to end customers (television broadcasted over the internet), need an infrastructure service in order to be able to send events in the quality demanded (ibid).

Furthermore, there are system owners and application owners among other roles, who are responsible for the functionality and operations of systems and applications. They may also be customers to IT Infra who order required infrastructure services in order to upgrade their systems and applications. In infrastructure transformation projects, there are typically a large amount of systems who are migrated into the new infrastructure environment. For example, it may be the case that security regulations require systems to migrate into a new data protection environment. Also, the projects are often dependent on cooperation from these stakeholders in order to understand how applications are affected when doing change work, as well as being allowed to do changes at a certain time. This can be exemplified when doing changes on server level. There may be many systems connected whose operational conditions are affected at the time when changes are being done. If a system needs to be temporarily down, it is important to know that it does not have any damaging effects on the up-and-running business services and the end customers they are serving (ibid).

Moreover, there is the IT Operations (IT Ops) department who will be responsible for the technical operation of the new infrastructure environment whilst it is up and running. In the best of worlds, the handover phase always goes smoothly. However, as operative requirements need to be considered, involvement by IT Ops in the projects may be necessary to make sure that the operative requirements are met. It also happens that third-party suppliers who have delivered new infrastructure environments are contracted to operate them as well (ibid).

Likewise, there is the development department who develops new application features, new system functionality and other software. They mainly interact with IT Ops and business units to develop new functionality which meets operative capacity (ibid).

Projects included in the study

In this study, five projects with different aspects of IT infrastructure are taken into consideration, both on-going and finalized ones. All the projects are structured in the same way, starting with a planning phase where the core planning is made and the scope is decided followed by an execution phase where the projects start to run and being executed. However, as mentioned before, this study only focuses on the execution phase. The projects included in the study are:

- A completed major data center consolidation program divided in a number of sub-projects in Sweden, Norway and Denmark with a strategic purpose to improve operational efficiency of server halls and data centers. This was done by moving applications and systems closer together into just a few data centers, operating in a new private cloud environment. The scope included more or less all of the IT systems belonging to Broadband, Mobility and Group IT. The program included transformation and rationalization of the infrastructure of those systems to new, modern and resilient environments in target data centers. The program would increase the virtualization and reduce the number of physical servers as well as the number of data centers from 44 to 4 (ibid).

- An ongoing program with its origin from when the above-mentioned data center consolidation program decided to focus on systems and applications rather than infrastructure. The intention with the program is to build up the overview of systems and enable a better infrastructure foundation to facilitate for infrastructure transformation. This involves the handling and upgrading of unsupported infrastructure services operated by IT Ops (ibid).

- A project which is about moving the company to a new generation of storage equipment. This is done together with two major vendors for storage. The vendors deliver the equipment and together with Telia, they run a project to migrate from the old equipment to the new equipment. The project started due to old storage equipment that needs to be renewed, since they are reaching end of life and becoming expensive to maintain (ibid).

- A project which is about moving from an old solution to a new environment for data protection in terms of having back-up of all data (ibid).

- A project which is about moving the mobile data network from own hardware to a virtual platform for this (ibid).

1.8 Disposition of the Thesis

To help the reader to follow in the paper, the structure and content of the succeeding chapters will be explained. Firstly, the introduction chapter, including a sub-chapter of the commissioner company essential for the reader to facilitate understanding of the IT infrastructure transformation projects, which is followed by a theoretical framing chapter.

Chapter 2 brings forward and discusses previous research with regards to agile practices, principles and frameworks considered in the study. Besides, the concept of agile and Scrum, Kanban and SAFe are described in more detail.

Chapter 3 explains and motivates the methodology chosen to conduct the case study as well as the benchmark. The chapter also comprises a discussion of quality and ethical aspects of the chosen method.

The empirics chapter, Chapter 4, is intended to provide with an objective presentation of the collected empirics. The chapter ends with a compilation of it.

The analysis chapter, Chapter 5, is then analyzing the empirical findings combined with agile theory, in order to draw conclusions about suitable agile ways of working in the context of IT infrastructure transformation projects.

Finally, the conclusions chapter, Chapter 6, presents a model which corresponds to the conclusions from the analysis chapter about agile ways of working intended for IT infrastructure transformation projects. Lastly, the chapter ends with answering the research questions, the managerial-, sustainability- and academic implications are discussed followed by limitations and future research of the study.

2 Theoretical Framing

In this chapter, the concept of agile including the underlying history is introduced along with previous research about its field of applications. This is followed by previous research and theory about three agile theoretical frameworks, namely Scrum, Kanban and SAFe.

2.1 Introduction to Agile

Agile is on everyone's lips, any and every organization wants to become agile. One of the most recent buzzwords added on the list in the world of software development is agile indeed. Despite its popularity, it still prevails confusions around the word "agile" and people seem to have their own definitions of its meaning. The misunderstandings are many, particularly the way to develop a successful implementation of an agile development process. Often people associate the word agile directly with a certain agile framework such as Scrum, but in fact the content of agile covers much more than defined frameworks (Cobb, 2011). However, the Agile philosophy is grounded on concepts and ideas from several IT governance and delivery frameworks.

The concept of Agile

If we travel back in time, the concept of agile was born as a revolutionary movement in contradiction to traditional project management methodologies. One of the methods which has been criticized is the well-established Waterfall model, associated with heavy documentation, unmanageability and unproductivity as well as high level controlling bureaucracy. The model is running as a series of small waterfalls of chronological phases with the initial phase as a start which flows to the next small waterfall one by one to the end of the project (Cobb, 2011b).

Further on, agile can more specifically be traced in the late 40's in Japan through Toyota and Lean thinking. Parts of the Agile thinking is established on the so-called "Toyota Production System", more acknowledged as "Lean" today. The manufacturing part of lean is left out, instead the innovative lean product environment can be resembled with the dynamic environment of agile. Another breakthrough took place in the 90's when Rapid Application Development, shortened as RAD, hit the market. The RAD framework focused mainly on product delivery regardless of the project governance and the ship sunk when the word "RAD" was equalized with delivery failure. The cause of the breakdown was due to misusage of the concept. Organizations claimed they used RAD to improve their deliveries but exclusive of any changes in the culture and behaviors of the organizations, it did not show any prominent results (Measey, 2015). After this flop, a few new frameworks were evolving. During the 90's, the IT industry was hit by a wave of failed software development projects with overreached deadlines, exceed budgets, defective deliveries and unsatisfied customers. Leaders within the IT sector suspected over-planning, lacking communication and "all-at-once" delivers as the root cause of the failures (Cooke, 2012). Nevertheless, the rescue came in 2001, when the concept of Agile truly was established by the defined Agile Manifesto which also covers all the previous frameworks. The Agile Manifesto stands for the widespread definition of agile, including development and delivery of agile frameworks (Measey, 2015).

The Manifesto for Agile Software Development is formulated by 4 values with support of 12 principles. An excerpt from the Manifesto and the values follow as (Measey, 2015):

"We are uncovering better ways of developing software by doing it and helping others do it. Through this work, we have come to value:

1. Individuals and interactions *over* processes and tools.

2. Working software *over* comprehensive documentation.

3. Customer collaboration *over* contract negotiation.

4. Responding to change *over* following a plan.

That is, while there is value in the items on the right, we value the items on the left more."

The following 12 supporting principles are stated as below (Measey, 2015):

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage

3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale

4. Business people and developers must work together daily throughout the project

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done

6. The most efficient and effective method of conveying information to and within a development team is face-to-face communication

7. Working software is the primary measure of progress

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely

9. Continuous attention to technical excellence and good design enhances agility

10. Simplicity – the art of maximizing the amount of work not done – is essential

11. The best architectures, requirements and designs emerge from self-organizing teams

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly

In summary, agile can be explained as the generic term for methods and practices to improve software solutions considering its relevance, quality, flexibility and business value (Cooke, 2012). The title of the manifesto underlines its implementation within software development, but the values and principles of the manifesto can be effective when developing other products and solutions beyond the software sphere. In fact, any organizations working in dynamic environments with variability in terms of unpredictable uncertainties and changes, can benefit from Agile values and principles (Measey, 2015).

Agile Implementation

If comparing the concept of agile and traditional project management methodology when developing software applications, a study stresses the strain with complex processes in the software activities, regardless of method. Hence, errors are commonplace in these projects. Accordingly, the crucial part of it is to test and validate the systems, not only just before releasing it to production but continuously during the development as well (Stoica et al., 2013).

Moving to the support for applying agile methodologies seen in a previous study of IT projects, it is stated to improve efficiency, satisfaction of stakeholders and project performance. Also, the value of vision and goals have shown to be improved in the projects by the agile approach. However, team experience and project complexity were not related to success in the study (Serrador & Pinto, 2015). While the implementation is challenging and not a guarantee for success (Gregory et al., 2016) (Rasnacis & Berzisa, 2016), some more additional success factors related to agile PM have been shown, relating to people factors, training customers, team size, team capability, team motivation, company culture, planning and scheduling.

There are numerous agile frameworks and some of the most popular ones are the Scrum and Kanban frameworks (Rasnacis & Berzisa, 2016). Many success stories about using agile frameworks have been reported, particularly in smaller projects and teams, but mixed opinions also exist. In order to fully succeed with agile implementation, it is crucial to understand the reason why one is using it in the first place (Measey, 2015). Hence, it is recommended to define what agile means to the organization and what one wants to achieve with it before starting the agile work (Reifer, 2002). A common mistake is to lean back to old routines after working according to agile approaches for a while (Measey, 2015). Further, the choice and adaptation of agile project management methodology is dependent on project type, company and employees (Gregory et al., 2016). The agile frameworks including the principles can be combined according to the fit of the specific project, but even other project management approaches can be incorporated to balance control and agility (Cobb, 2011).

A common perception by people, particularly from the business side, is to think that agile only has impacts on the development side of the organization, but the reality is different. In order to become more agile, commitment from business to work together through close collaboration with the development is required. To make this work, it might include changes in the culture and mindset

of the organization (Cobb, 2011). It is important to point out that doing agile is not equal to being agile, but demands for actual change (Denning, 2016).

Another point to be aware of is that the design of the different agile frameworks does not describe in every detail what and how to do in the implementation. Agile is not something that can be followed and implemented "by the book". Instead, the frameworks are based on principles and values which need to be understood and translated according to the given context. Also, agile methodologies are about continuous improvements where the approaches mature with time, meaning that what will work and not is still a learning process. Hence, interpretation of the different frameworks on a profound level is crucial, specifically when selecting among the frameworks (Cobb, 2011). Further, recommendations from a previous study on agile implementation in ten different industries, states to build a business case with only quantitative data to verify the change. These changes need to be related and supported by the chosen agile approach including guidelines, checklist and key performance indicators for the starting point. Likewise, learnings from earlier experiences, education and training, available for everyone, should also be offered (Reifer, 2002).

When having projects or programs consisting of more than ten development teams, numerous actors as well as systems leading to countless of interdependencies, the scale of these projects and programs into agile approaches is a true challenge. It is much harder to coordinate the teams and projects including the smaller subprojects, as well as the involvement of customer and maintain software architecture (Dingsøyr et al., 2018). A common mistake is to apply agile practices from succeeding small-scale projects to larger business units and functions with the hope of same results. To benefit from agile methodologies even in these larger constellations, one must reconsider the basis of processes, structures and relationships. The changes must be made at least in one or several parts of the operation model, specifically in the parts of modifying the organization structures into being more product oriented, enhancing the interaction and modifying the roles in the business and IT, as well as alter the budget and planning for them (Comella-Dorda et al., 2016).

Other aspects which can be challenging to manage when implementing agile ways of working is the constraint to allocate cross-functional teams with diverse competence from different areas of the organization. Besides, to allocate these project members with full-time dedication to a project and gather the whole project team to work at the same location are further difficulties (Conforto et al., 2014). As a first step, it is important to prepare the team before the implementation takes place (Rasnacis & Berzisa, 2016). Moreover, the involvement of key customers and suppliers in the development of the projects has also been stated as a challenging remark. Regardless these challenges, other industries can still make benefits from using agile methodologies (Conforto et al., 2014).

Agile and IT Infrastructure

When talking about agile IT infrastructure, it includes IT platforms as well as IT applications. Considering these two parts, aspects related to agile have been reported in a previous study. Firstly, an IT platform makes it possible for faster development and deployment of business systems to upkeep internal requirements of the business. Standardizing the IT platforms can support for faster reconfigurations as well as integration of the resources within IT. Further, applications, data and other technical components which are connected more loosely allows global companies to create

and customize parts according to local requirements but following international standards as well. Secondly, IT applications on the other hand, assist the agile interaction and cooperation. The IT applications can support rationalization of system development processes via communication and collaboration through the internet. Also, communication and collaboration with the help of digital tools as for instance video calls are essential when wanting to become agile and having a distributed project team (Lee et al., 2006).

However, there are different views of applying agile on infrastructure projects. Some have the belief that agile and infrastructure is a misfit. A study has shown that agile infrastructure projects succeed if the technical-, project- and operational parts are stressed in the project. According to the study, the technical aspects is the simplest to handle since tools are getting both established and integrated, but mainly because people with an IT background often find it easy to grasp these aspects as well. Developing the technical establishment facilitates the integration with the infrastructure work. Consequently, integrating volatile operational processes, working with non-project based tasks and distributing resources of operations within different projects are the most difficult sides with it (Debois, 2008).

Moving further, a number of challenges that agile practitioners face has been identified. With regards to IT transformation, this includes many expressed challenges on establishing collaboration between IT and business to achieve agility throughout the entire value chain (Gregory et al., 2016). Another study has stated implementation of agile methodologies in IT infrastructure maintenance work as extremely difficult. The work can easily be divided into sprints in maintenance work, but interaction regarding tasks and common goals are not included as it is naturally in development work. Moreover, maintenance team work with various customers seated in other places results in obstructed communication (Ahmad et al., 2016).

2.2 Scrum

Scrum is a highly popular framework by being the most implemented agile framework across the globe presented by Ken Schwaber in 1994 (Measey, 2015) (Ozieranska et al., 2016). The word "Scrum" descends from rugby and the team set up within the sport. The team wants to move forward as a joined force with equal efforts taking place at the same time in order to reach a shared goal. To achieve the certain goal, every player has their own talent and role. Scrum is an agile project and product management framework with unique values, activities and artifacts to deliver products (Moreira, 2013). The problems Scrum intents to target is the complexity occurring in software development projects. The solution for this is the review, adjustment and visibility requirements of empirical process control including some practices and rules (Measey, 2015).

In previous studies, Scrum has shown to be fruitful in improving processes at IT organizations, particularly organizations smaller in size (Łukasiewicz & Miler, 2012). However, there are many factors which need to be in place in order to successfully implement Scrum in an organization. Hence, it is important to underline that the benefits from Scrum merely will be evident when all central activities, roles and artifacts presented in the framework are applied. Correspondently, it is where the challenge lies when implementing the framework (Measey, 2015). Vast expenses in terms of money and motivation of the people of the organization will be lost if failing with the

implementation of Scrum (Ozieranska et al., 2016). For instance, one of the central practices in Scrum is the width of communication modes such as phone, telephone conference, video conference, email and instant message. If there is a lack of shared ground or goals, conflicts and interference may be the case (Hayata & Han, 2011) (Hossain et al., 2009).

Another challenge with Scrum but also other agile frameworks, is to scale up the frameworks. Besides, developing large software systems requires inputs and insights from other stakeholders within the project to make decisions. Thus, it is not sufficient to limit the implementation of agile values and principles solely at the team level. As Scrum mainly was intended to be applied on individual teams, it can be problematic when managing larger complex projects (Laanti, 2008).

Furthermore, previous studies have shown, when the Scrum team is globally distributed, several challenges will reside since the distance affects the communication, coordination as well as the collaboration process. If there is a shortage of tools and poor support of the infrastructure, this has further negative impact on the Scrum implementation. To master the challenges, the team members should use strategies according to their development environment such as syncing the work hours and extra team meetings locally (Hossain et al., 2009). Nevertheless, if one could deal with the challenges, faster problem solving could be reached regardless the split distribution. A study has noted a more open conversation since applying the Scrum meetings, specifically in countries with a culture of not discussing problems openly. Also, the barrier to talk to the colleagues overseas was dissolved (Paasivaara et al., 2009).

The Foundation of Scrum

The foundation of Scrum is built on an iterative and incremental process which consist of a daily inspection, iteration of development activities, product backlog and increments of functionality (Schwaber, 2004).

The iterations (corresponding to sprints later on) of development activities take place one by one and the result of every single iteration is an increment of product. The daily inspection on the other hand, come to pass along with the iteration where the team members can inspect one another's activities and make adjustments if needed. The iterations are run by a list of requirements and the cycle continues as long as the project is still financially supported (Schwaber, 2004).

If starting with an iteration in Scrum, the team needs to evaluate the tasks and pick the increment which they consider have potential for being developed to a functionality at the end of every iteration. This responsibility lies with the team and the iteration ends with a presentation of the developed increment of functionality in front of the stakeholders. By this presentation, the different stakeholders can review the functionality and coordinate the project considering time. The iteration is the very core of Scrum, where the team goes through the requirements, accessible technology and makes evaluation of competence and capacity of their own. Further on, the team together decides how to build and adjust the functionality considering any complexities that have emerged during the day-to-day work. The next step for them is to find out how to get there with the most appropriate directive approach. This described process is the core of the effectiveness of Scrum and can be seen in Figure 2 (Schwaber, 2004).

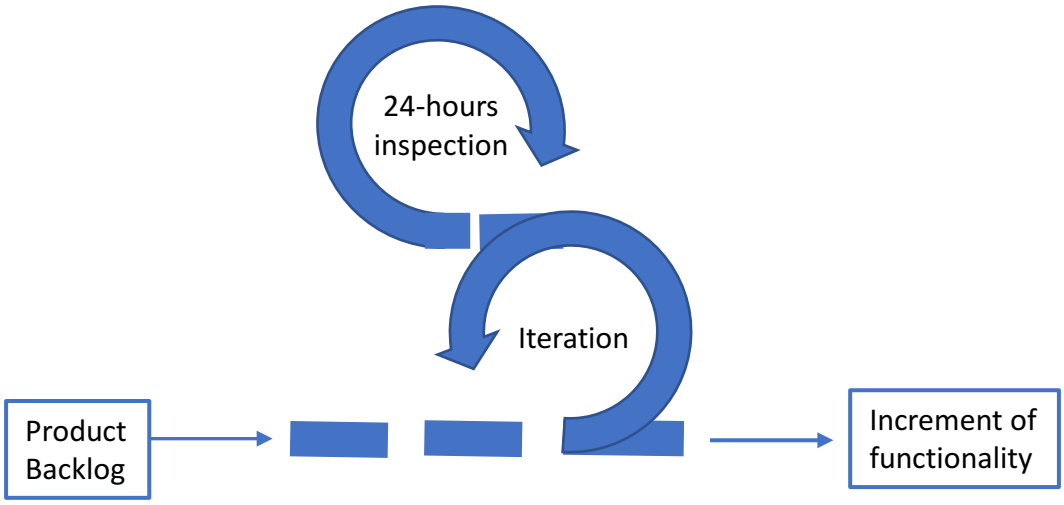

Figure 2. The foundation of Scrum built on an iterative and incremental process.

Drawn by source: Schwaber (2004).

The Scrum Roles

In Scrum, there are three roles that are in charge of the management of a project. These Scrum roles consist of: The Product Owner, The Team and The Scrum Master (Schwaber, 2004).

The Product Owner

The product owner is the one with the responsibility to stand for the interest of the people involved in the project, such as various stakeholders. By getting financings for the project, the general requirements, return on investment goals and release plans of the initial phase can be created. The product owner has the obligation to make sure that the most value-adding functionalities are prioritized in the project. The tool for realizing this, is by making use of the product backlog which is a list of functional and non-functional requirements for the project. Through continuous prioritization of the requirements for the upcoming iterations, the most potential functionality can be chosen. Furthermore, since the product owner works closely with people such as product managers, business analysts, customers and other stakeholders to evaluate requests, the role functions as an allied spokesperson between the development team and the remaining part of the organization (Schwaber, 2004). Another area of responsibility of the product owner is to communicate well-defined visions and committed points to the members during the sprints and the release phase. Also, the role includes putting a face outwards by activities such as stakeholder management and taking part of meetings concerning strategy and portfolio management. The product owner expects to be supportive by being available to answer questions with instant response and direct the team by face-to-face contact (Measey, 2015).

The Team

The main task of the team is contributing to functionality. A Scrum team has characteristics such as being manageable, organized and cross-functional with different expertise by its own nature (Schwaber, 2004). Common roles including in a Scrum team can be for instance, coders, testers,

architects, analysts, specialists and other roles with supporting functions (Measey, 2015). Their responsibility lies in transforming items from the product backlog to functional increments in terms of sprint goals during the iterations. The team has shared responsibility together with the Scrum master of the outcomes of the iterations and the overall project (Schwaber, 2004). Communication is central within the team, the number of team members in a Scrum team is recommended to be between five to nine in order to keep up effective teamwork and interactions to develop items of excellent quality at the end of the sprints (Measey, 2015).

The Scrum Master

The function of the Scrum master is to be in charge of the whole Scrum process. Further, this means to share the philosophy of Scrum to all participants of the project and to apply Scrum accordingly to the culture and values of the organization. More importantly, the Scrum master has to engage everybody to use rules and practices of Scrum. In this way, Scrum is expected to create value for the organization (Schwaber, 2004). The Scrum master is the single owner of values, principles and practices of Scrum applied to the projects. Implementing Scrum among the teams requires a strong leader with approaches of mentorship and coaching. When the team faces any obstacles, the Scrum master will be there to solve the concerns by utilizing relevant agile frameworks. Thus, letting the team focus on aiming for the sprint goal. Involvement on the organizational level by adopting Scrum with an organizational twist also lies on behalf of the Scrum master (Measey, 2015). Not everyone can take on the role as the Scrum master, it has to be someone dedicated to the project with the authority to decide what's best for a project (Schwaber, 2004).

The Scrum Process

When implementing Scrum on a project, the process starts with defining the vision of the intended developed system. At the very beginning, the vision may be unclear but will during the project process moving towards being more clarified. The vision provided by the funders should be of value in order to raise the return on investment to the maximum. The product owner has the responsibility to ensure this requirement and sets up a plan for it by the product backlog. When these requirements are transformed to functionality, the vision will be realized. Moreover, the items in the product backlog is prioritized by the item with most potential value at the top and gets divided in intentional releases. The division of the product backlog including the content, priorities and grouping will change during the process and visualize changed business needs. The changes indicate the rate of transformed product backlog to functionality by the team. The work during the entire project is executed in a number of iterative sprints of 30 days. The sprints start with a sprint planning meeting with cooperation between the product owner and the team regarding the activities included in the upcoming sprint. By picking the item with highest priority, the product owner let the team knows what is anticipated while the team estimates the degree of fulfillment to functionality and confirms it back to the product owner. The sprint planning meetings are time-boxed and limited to last for maximum eight hours, to not dilly for too long and get to work as an effective routine. The sprint planning meeting is divided into two phases, with the first four hours where the product owner bring forwards the product backlog with highest ranking in front of the team. During the first phase, the team is supposed to ask questions so the content and objective of the product backlog gets clearer to them. The first four-hour session ends with the team deciding the amount of product backlog as it considers it can transform to finished increment of product functionality at the finish line of the sprint. In the second session with four hours, the actual time-

boxed sprint has begun with 30 days in hand. This phase starts with the planning of the sprint which takes care by the self-managing team. The tasks included in this plan are put in a sprint backlog as the sprint is followed (Schwaber, 2004).

During the project, the team gathers for a daily meeting of 15-minutes, so-called Daily Scrum where three questions are raised among the participants (Schwaber, 2004):

1. What did you do yesterday?
2. What do you plan to do today?
3. What is getting in the way for you?

The aim with the daily scrum is to has a decided time where all the team members meet to coordinate work and share progresses.

Further on, when reaching the finish line of a sprint, the sprint will be closed with a sprint review meeting of four hours which is time-boxed. The purpose with the meeting is for the team to talk about the sprint session, more specifically the development of the functionality within the sprint period. The main audience is the product owner, but the meeting is also open for other interested stakeholders to join. Another intention with the meeting is to bring the participants closer to each other and strengthen teamwork so they together can decide the following step for the team. The sprint review and the following sprint planning meeting, are followed by a time-boxed three hours sprint retrospective meeting held by the Scrum master together with the team. At this meeting, supported by the Scrum master, the team is supposed to reflect on their experiences, in particular how the Scrum process framework and practices can improve and be more efficient for the upcoming sprint (Schwaber, 2004). The entire process of Scrum including the described activities can be seen in Figure 3 below.

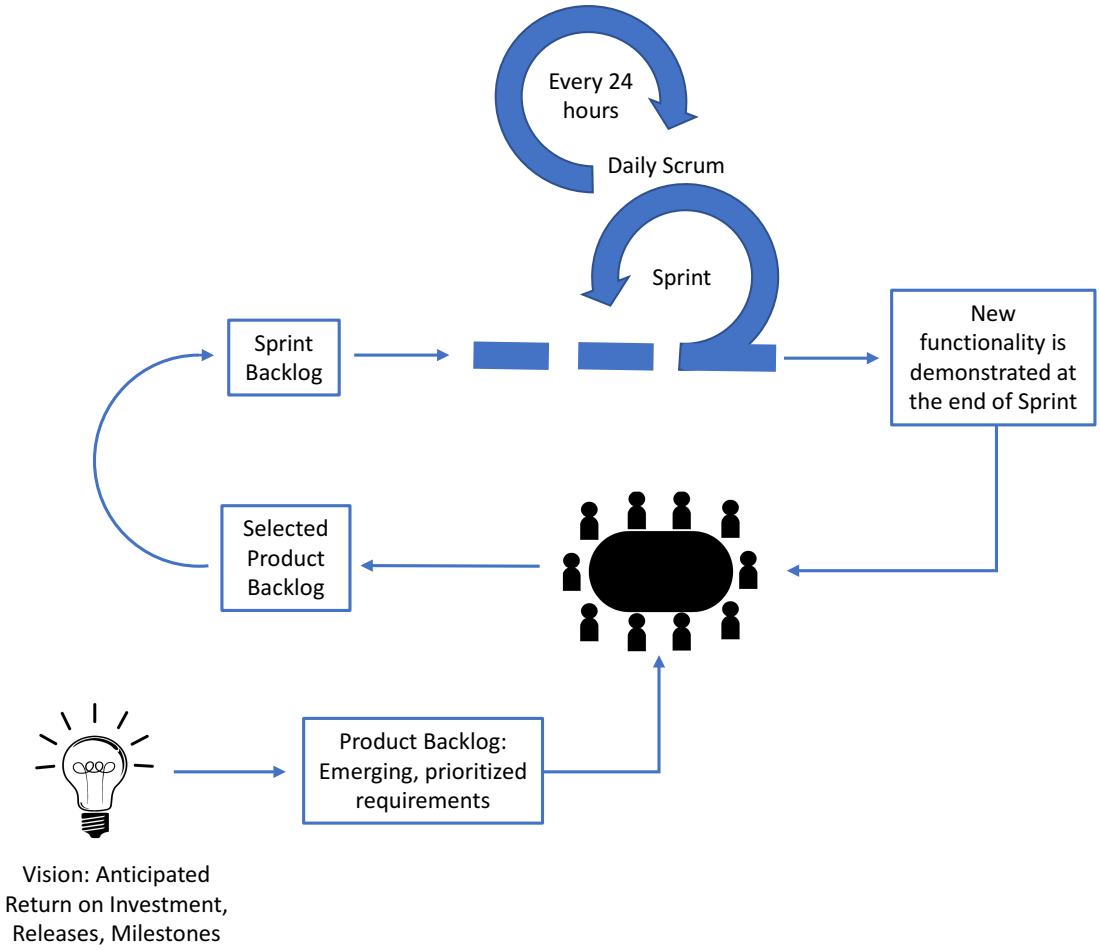

Figure 3. An overview of the SCRUM process.

Drawn by source: Schwaber (2004).

2.3 Kanban

Kanban is not an agile software delivery method, but rather a method which aims to continuously improve service delivery and which gives special prominence to smooth and fast flow of work (Measey, 2015). The method is rooted in lean production with its origin from Toyota and its "Toyota Production System". At later years, more closely in the 2000s, Kanban has started to be implemented in software engineering and IT projects (Hofmann et al., 2018). It was David Anderson who introduced the Kanban method in 2004, when helping an IT team at Microsoft to visualize and limit their work in process (Banijamali et al., 2017). Kanban can be advantageously used for delivery and maintenance of IT systems and it is also seen as a method for improving organizational agility. It does not classify specific roles or ceremonies since it is centered around evolutionary change. Understanding how the system works and continuously improve the flow of work by visualizing it and measuring it is key (Measey, 2015). The literal translation of *Kanban* consists of *kan* which means visual and *ban* which means card or board (Cobb, 2011a). The Kanban board is not limited to only a single team and iteration, but empowers collaboration with several

teams and people from different divisions to develop complex products and solutions including hardware, software and maintenance work (Hofmann et. al., 2018).

Nowadays, Kanban is used to complement different agile methods such as Scrum when handling IT development (Al-Baik & Miller, 2015). An advantage of implementing Kanban over Scrum is that it can be implemented successfully in traditional and command-and-control cultures. However, the Kanban method will not help to develop the agile mindset as efficiently as Scrum, by simply following the practices. However, by using support from the Agile Manifesto, this may be achieved though (Moreira, 2013).

When implementing Kanban in the field of software development, critical challenges have been seen due to the lack of defining the principles, practices, techniques and tools in a well-defined way. As an example, sometimes the principles are numbered as five but also as many as fourteen can be found in the literature. Moreover, there are no defined implementation guidelines or practices when introducing it to IT organizations (Al-Baik & Miller, 2015). Consequently, the implementation of Kanban tackles defiance from managers, developers and trainers who need to be convinced. Other stressed challenges which involve organizational culture and mindset including shortage of practice and misinterpretations of the Kanban concept (Ahmad et al., 2016). Another anticipated issue related to Kanban and the IT industry is the tendency to work silo-based on islands (Al-Baik & Miller, 2015).

In addition to commonly addressed benefits of Kanban from the literature, such as being an effective tool for visualization and safeguarding the development process to follow as predicted, further advantages haven been stated (Al-Baik & Miller, 2015). In a study performed on two teams from two large software companies, it showed that Kanban is preferably used in work with high variability in priority. Progress has been visible when applying Kanban into work with tasks which often changes, such as in maintenance work. The improvements include the team taking on the most critical work more naturally, work being pulled towards the highest level of priority and improved throughout as well as efficiency owing to work-in-progress (WIP) limitations (Ahmad et al., 2016). Also, the cooperation with the stakeholders enhanced with pronounced operation rules when using Kanban (Reveco et al., 2014). In silo-based way of working, Kanban has counteracted and made teams to collaborate to achieve high quality but also minimize the need for additional resources. To lead organizational changes and support cross-functional teams in an efficient way are more benefits from the Kanban method (Al-Baik & Miller, 2015).

However, taking advantage from the benefits of Kanban requires several attempts before everything falls in place including problems with integration and coordination as well as misunderstandings. Yet, implementation of Kanban led to progress all the time rather than falling back to the initial state (Reveco et al., 2014). Hence, it is suggested to discuss the concept and principles of Kanban together to bridge the expressed literature gap as well as create a shared foundation to work from. Further, this can help to form guidelines on a structure for Kanban way of working in IT organizations and enhance the success factor with the method (Al-Baik & Miller, 2015).

The Kanban method has six core Kanban practices (Measey, 2015):

- Visualizing the work
- Limiting WIP
- Making policies clear
- Measuring and managing flow
- Implementation of feedback loops
- Improving collaboratively and evolving experimentally

Visualizing the work

Visualizing the work includes the work, the workflow and business risks. In a software delivery system, it is necessary to visualize every step in the value chain from vague idea to software release to succeed with effective management of end-to-end delivery processes. This can be done with post-it notes or similar on a physical board, where workflows from left to right across the board (Measey, 2015). It is recommended that the team members are a part when outlining the boards to boost the involvement and satisfaction (Al-Baik & Miller, 2015).

Limiting work-in-progress

Work items refer to customer-valued work and not tasks. Limiting the amount of work items being worked on simultaneously is an effective way of improving the flow of work, even if intuition might say differently. In Kanban teams, it is the flow of value which is interesting to track rather than effort being spent. Thus, work is organized to deliver what the customer needs when the customer needs it. WIP at particular process steps is managed by a "one-out-one-in" pull approach in order to limit the WIP (Measey, 2015).

By lowering WIP, a number of advantages can be achieved (Measey, 2015):

- Reduces coordination costs because there is less to coordinate
- Reduces multi-tasking
- Increases focus
- Improved responsiveness to unplanned events and process failures
- Reduced lead times (according to Little's law, average lead time is directly related to WIP)
- Lowering WIP limits drives collaborative improvement of the whole process. Managers and operators from process steps encountering overcapacity will investigate the visualized upstream and downstream process steps, thus developing process flow optimization.

Setting the WIP limits too high will have no effect and setting them too low will stifle the flow of work. Experimenting with WIP limits is encouraged to find out the optimal WIP limits, since it is easy to reverse any changes in WIP limits (Measey, 2015).

Making policies clear

Process policies that apply to the process should be documented, including management, risk management and process policies. This may include checklists on what needs to be done in order for a process step to be considered done or documentation about how certain decisions are to be made (Measey, 2015).

Measuring and managing flow

By monitoring and measuring the workflow's transitions between process steps, a historical picture about e.g. the flow of work and lead times is obtained. By analyzing this, improvement areas can be identified and addressed, and previous process improvement attempts can be followed up (Measey, 2015).

Cumulative flow diagrams are potent tools which can be used to visualize the history of workflow. In these diagrams, it is possible to measure WIP levels on any given dates, average lead times and process steps transition rates (Measey, 2015).

Implementation of feedback loops

Feedback loops are encouraged at all levels when practicing Kanban methodology. Feedback loops facilitate the learning of the process and the effects of changes made to it (Measey, 2015).

Improving collaboratively and evolving experimentally

Central for the Kanban methodology is the creation of a culture which fosters continuous change and improvement. Everyone in the organization is accountable for contributing to continuous improvement and everyone should feel empowered to make changes (Measey, 2015).

Scrumban

To combine different frameworks is recommended by some people, while other studies have shown it to be better to run the frameworks separately at the same time, in particular, Scrum and Kanban (Polk, 2011). There is a management framework built exactly on the combination of Scrum and Kanban, so-called Scrumban. Taking the best out of both the frameworks, the intention with this combined framework is to outcompete the original Scrum and Kanban. However, the full capability and impact of using Scrumban on software development are not yet identified due to limited studies. In one study, where the combined framework was implemented on software factories, the framework improved several expressed challenges. Although, additional research is needed to make a statement. (Banjimali et al., 2017). Further, the framework is simplified by keeping the daily meetings from Scrum and the board from Kanban, while planning activities and measurement of velocity are cut out. Consequently, Scrumban might not be effective for large development projects, but for activities and projects smaller in size (Ellis, 2016).

2.4 Scaled Agile Framework (SAFe)

The topic of scaling agile has caused much discussion in the agile forum. Some research discusses the challenges and provide with some guidance for scaling agile practices in large organizations who are transitioning from traditional paths (Boehm & Turner, 2005) (Mishra & Mishra, 2011) (Mahanti, 2006). It has also been lifted that the greatest challenges do not lie in the agile practices per se, but in their relations with existing organizational processes. Furthermore, it is challenging to establish support for cross-team communication and coordination, which are seen as problems that agile practices do not address (Lindvall et al., 2004). While the literature is rich of books with agile methods laying out abstract decision-making processes, authors have pointed out the lack of research on large-scale adoption in practice that offers well-documented results and learnings (Brown et al., 2013) (Paasivaara, 2017). IBM's experiences from working with clients trying to

adopt agile techniques at enterprise-scale level have shown that success requires economic governance, measured improvement and disciplined agile delivery (Brown et al., 2013). In observations made by McKinsey & Company, companies who are deploying agile at scale have seen their innovation pace accelerated by up to 80 percent (Comella-Dorda et al., 2016).

While there are frameworks for scaling agile such as disciplined agile delivery (DAD) and large-scale Scrum (LeSS), the Scaled Agile Framework (SAFe) appears to be the framework for scaling agile which is the most fully equipped, discussed and implemented. This view is shared by Measey (Measey, 2015) and supported by studies (Ebert & Paasivaara, 2017). Furthermore, the SAFe framework appears to provide with the most amount of empirical observations from real-world adoption cases found in the literature.

Case studies offer a few encouraging results on SAFe adoption, but also a lot of challenges. As a response to an observed lack of a well-structured gradual approach for establishing SAFe, Turetken et al. has developed a SAFe maturity model in an attempt to provide guidance for companies in defining a roadmap for adopting SAFe and which can also be used to assess the state of SAFe adoption (Turetken et al., 2017). At two companies considering their deployment of SAFe a success, i.e. Napa and Comptel (a telecommunications company), a number of success factors could be identified. These included customization of the framework in order to suit the organization, investing in the first program increment planning event in order to make it a success, the employment of external consultants for training and coaching, having active and engaged internal change agents, having strong support from leadership and quickly responding to feedback in order to continuously improve and remove the impediments of adoption (Ebert & Paasivaara, 2017). The investment in a full-time release train engineer at Comptel was also a success factor (Paasivaara, 2017). The adoption of SAFe resulted in more frequent, predictable and qualitative releases, improved visibility and communication, enhanced visibility and communication across the globally scattered organization, improved synchronization and collaboration across different teams, better discovery of dependencies and dependency management, and improved alignment across the organization (Ebert & Paasivaara, 2017). Another real-world example illustrates the positive impact on multiple team collaboration by the help of program increment (PI) planning meetings, which is an essential element of the SAFe framework (Brenner & Wunder, 2015). Despite contrary expectations, these meetings have been shown to be able to be well structured and highly productive (Brenner & Wunder, 2015), even in the context of globally distributed meeting participants (Paasivaara, 2017).

The Scaled Agile Framework (SAFe) is a scaled approach for agile adoption, created by Dean Leffingwell. It was developed in order to provide with effective practices helping with the problems found at large software organizations, which the methods of Scrum and eXtreme Programming were insufficient to address (Measey, 2015).

The framework provides with (Measey, 2015):

- A process model involving the highest level and the lowest level of the enterprise, where especially important activities are:
    - The program increment, PI, which is a mid-level planning cycle occurring after every 4-6 sprints. The PI covers the activities of the different agile teams in the program, typically 5-12 Scrum teams.
    - The funding of the programs. The stable and long-term programs are aligned to a value stream (the flow of value to the customer).
- Associated Agile values and practices, many of whom are related to other Lean and Agile approaches such as eXtreme Programming, Kanban, Lean thinking and Lean product development flow and the Agile Manifesto.
- Four core values - code quality, alignment, program execution and transparency.

SAFe Process Model

The SAFe framework is structured into three layers - team level, program level and portfolio level (Measey, 2015). A picture of the full framework, its different levels and components, is shown below in Figure 4.

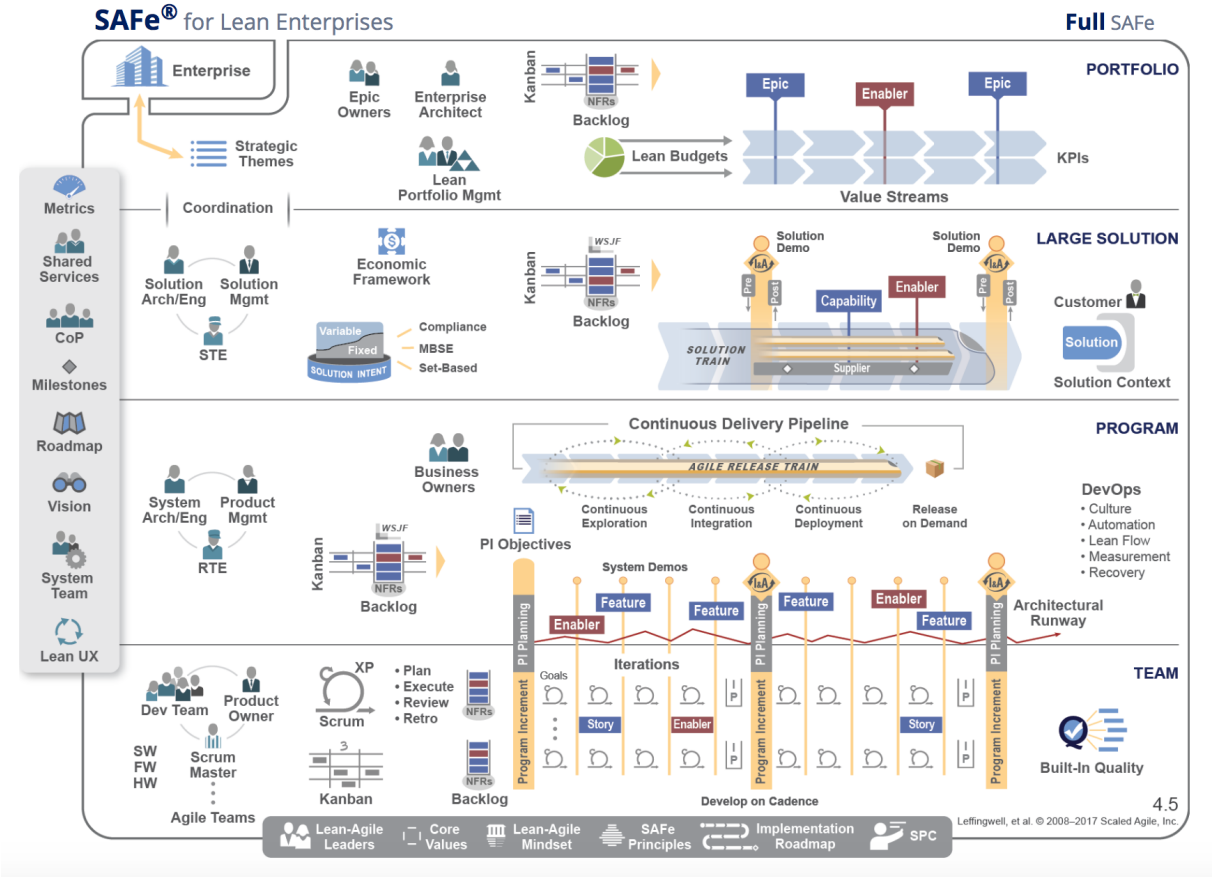

Figure 4. Overview of the Full Scaled Agile Framework.

Source: Scaled Agile (2017).

Team Level

At the team level, the teams adopt agile methodologies such as Scrum (or Scrumban) and eXtreme Programming (Measey, 2015). System teams typically adopt Kanban as their main practice (Scaled Agile, 2017) (see system team below). However, there need to be some adjustments made from those frameworks in order for the team's roles to fit into the program and to put emphasis on flow and the limiting of work-in-progress (WIP) (Measey, 2015).

Program Level

On the program level, it is the Agile release train (ART), or agile program, which aligns the cross-functional agile teams to a common business and technology mission. The "team of teams" plans, commits and executes together (Scaled Agile, 2017). As mentioned above, the ARTs are long-lived and are organized in a way that seeks to incrementally deliver end user value by carrying out a number of sprints between each program increment timebox. The timebox usually corresponds to 8-12 weeks (Measey, 2015).

In order to manage the inherent variability of systems development in a flow-based system, important events and activities occur on a predictable, regular schedule. This is referred to as *develop on cadence* and may include events such as program increment planning, system and solution demos and inspect and adapt (Scaled Agile, 2017). Releasing occurs on demand and the release frequency depends on the individual release trains (Measey, 2015).

At the program level, there are 9 roles defined (Measey, 2015):

- The **product management** prioritizes the program backlog as well as owns and communicates the product vision and roadmap.
- The **release train engineer** is responsible for driving continuous improvement for the program level and facilitates program increment release.
- The **business owner** is the senior management having ultimate responsibility for value delivery. The business owner participates in release planning as well as release inspect and adapt (see further down).
- The **system architect** helps to break down system-level stories and establishes a working relationship with the enterprise architecture.
- The **user interface team** creates a consistent user experience.
- The **system team** assists in building and using the infrastructure for the agile development environment (Scaled Agile, 2017). The team provides processes and tools for early and frequent integration and evaluation (Measey, 2015).
- The **DevOps** marks the skills needed by the programs in order to build and improve a rapid deployment pipeline.
- The **release management** is responsible for synchronizing releases with other programs and stakeholders.
- **Shared resources** provide assistance with specialist competence typically not found in the teams.

The program increments begin with a 2-day planning session where everybody in the program attends. PI objectives are identified (overall as well as team-specific) along with a release plan for the upcoming sprints, finalized by a vote of confidence from all participants. Throughout the PI, coordination between the teams is partly managed by standard scrum-of-scrums meetings,

facilitated by the release train engineer. By the end of each sprint, a system-level demonstration is given to relevant stakeholders in order to review progress. The last sprint may provide time for innovation and planning (Measey, 2015).

At the end of each program increment, there is an inspect and adapt workshop. This workshop is for the SAFe program, what a sprint review and retrospective is for the Scrum team. In other words, a time to reflect and make adjustments at program level (Measey, 2015).

Portfolio Level

The portfolio level involves (Measey, 2015):

- Coordination of larger initiatives, called epics. The epics require implementation over multiple ARTS.
- Funding of ARTs

The backlog of the portfolio contains epics crossing over multiple ARTs. The epics might be triggered by customer needs or be technology driven, so-called business epics or architectural epics. Before entering the portfolio backlog, the epics need analysis and approval. At this level, a Kanban system is used to handle the work (Measey, 2015).

As mentioned above, the ARTs are aligned within value streams. The ARTs are funded by associated budgets, determined by current business context and the portfolio strategic themes continuously evolving (Measey, 2015).

The roles are more loosely defined at the portfolio level in comparison to the other levels of the framework. The roles include program portfolio management, enterprise architecture and epic owners (Measey, 2015).

SAFe Agile Architecture and non-functional requirements

SAFe recognizes that incrementally growing design has its constraints at a scaled level. It is therefore necessary with design up-front. However, the design up-front should try to be "just enough" and "just in time" in order for teams to progress effectively (Measey, 2015). The *architectural runway* refers to the software code, components and technical infrastructure that is built just in time to enable new business features (Scaled Agile, 2017) (Measey, 2015). Furthermore, non-functional requirements such as reliability, scalability, maintainability, security, performance and usability are central architectural concerns in the SAFe framework. They are typically included in program backlogs, either incorporated within the backlog items or as single items (Measey, 2015). They set constraints on system design. They are just as important as functional epics, capabilities, features and stories. The usability and effectiveness of whole systems are enabled by them. If not meeting them, systems may fail to meet internal business, user or market needs. Not to mention, failing to fulfill mandatory requirements decided by regulatory or standards agencies. To meet non-functional requirements, it typically requires enablers (see below) to implement it (Scaled Agile, 2017).

Enablers

Enablers back the activities that are developing the architectural runway in order for future business functionality to be enabled, thereby driving better economics. They include exploration, infrastructure, compliance and architecture development. They are to be found at all levels of the framework and across various backlogs. Being treated as any other value-adding development activities, they are subject to estimating, visibility and tracking, WIP limits, feedback and presentation of results. Architectural enabler work is often overwhelming and therefore needs to be broken down into smaller stories to fit into iterations. However, this may be difficult since changes may cause systems to stop working until the new architecture, or infrastructure is in place. It is therefore wise to organize the work so that the system can operate most of the time in the old environment, thus allowing for teams to continue their agile progressions while enabler work is happening. When the enabler work cuts across multiple ARTs or streams, it is important to decide whether or not to implement the enabler simultaneously across all ARTs or to do so incrementally. The decision is based on a trade-off between the reduced risk of implementing the systems (or solutions) incrementally and the cost of delay by not having the full enabler in place (Scaled Agile, 2017).

DevOps

The concept of DevOps is a development methodology within Agile with the expressed strive to bridge the gap between the development and the operation department, thereof the name. The focus is to foster communication and collaboration as well as making integration as a routine. Likewise, safeguarding quality and deliveries with automation in terms of building, testing and deployment are included as core aspects of the methodology (Rana & Staron, 2016).

3 Methodology

In this chapter, the methodology used to acquire relevant empirical data for the study is motivated and explained. The methodology includes both a case study and a benchmark study which are supported by semi-structured interviews, internal documents as well as research papers. Furthermore, quality aspects of the study are discussed in terms of validity, reliability, generalizability as well as research ethics.

3.1 Research Approach

Considering the purpose of this master's thesis, to investigate how IT infrastructure transformation projects can be executed in an agile way at telcos, a qualitative method was followed to acquire in-depth insights by various data collection methods. The strive was to reach for rich data in terms of personal experiences and thoughts of individuals leading to contextual understanding of the investigated phenomenon, agile and IT infrastructure transformation, which can be gained through a qualitative approach (Blomkvist & Hallin, 2015). To capture closeness and be given long expressed answers would not have been possible through a quantitative method, for instance by using surveys. Consequently, it was therefore not considered and a qualitative method was used. As we wanted to identify significant dimensions of the challenges and opportunities within IT infrastructure transformations projects related to agile, an explorative purpose was intended for the investigation. Besides, there is limited research found in the scientific literature within the area. The investigation followed an iterative process fluctuating from an inductive to an abductive approach between the different stages of the process according to the nature of the study which will be described more in detail in the last section of this chapter, in section 3.5.

3.2 Research Design

The research design of this study is set as a single case study at Telia Company who commissioned the assignment of the master's thesis. A case study can be described as; to investigate an ongoing phenomenon on a profound level within the real-life context it appears in. This, particularly when the line between the phenomenon and context are unclear (Yin, 2009). The richness of the data provided by a case study can in turn result in applicable conclusions made to a commissioner (Collis & Hussey, 2003). Considering the scope of the investigated phenomenon, the research approach and the time set for the master's thesis, a single case study was chosen over a multiple case study. Although a multiple case study would have given a more generalizable view of the current situation at telcos, the mentioned aspects had to be considered. However, to cover and learn from other cases from the industry, a benchmark study was conducted instead. Further, the case study is chosen to be able to study Telia, particularly at the IT infrastructure transformation department, in-depth and obtain detailed information about their journey with agile implementation. Additionally, a case study as research design is suitable for research with questions motivated to know how or why, as in this case (Blomkvist & Hallin, 2015). Telia is a relevant case for this investigation, since they are a large, well-established telco who possesses a lot of legacy and who still has a long way to go in their agile transformation.

3.3 Data Collection

The data collection methods used in this study will be presented below, consisting of a literature study, review of internal documents, interviews and benchmarking.

Literature Study

A literature study was carried out by reading upon previous research and general facts from secondary sources in order to get an understanding of the field of project management as well as agile management and IT infrastructure. According to Blomkvist and Hallin (2015), a literature study can promote new ideas and helps to position the study related to previous research within the field. Further, information from books and peer-reviewed research articles about the foundation of the agile concept and methodologies including three chosen agile frameworks consisting of Scrum, Kanban and SAFe were collected. The selected frameworks functioned as the building blocks to create the agile model. The selection of frameworks was made subjectively based upon the nature of the investigated projects and their relevance to solving problem areas raised in the interviews. Also, it was taken into account that the investigated department had previous experiences of both SCRUM and Kanban, which are two of the most popular frameworks to use. Furthermore, these frameworks were addressed as most suitable for the nature of the investigated projects among the crowd active in numerous IT infrastructure and agile forums on the web. Besides, it is worth mentioning that over ten other frameworks also were studied before the selection. Yet, the three selected frameworks were considered the most appropriate for the case. Also, in order to get a depth in the creation of the agile model and not conduct a straggling study, we wanted to keep the number of frameworks to a few. Conclusively, the used literature material in this study originates from the scientific database KTH Primo and Google Scholar.

Review of Internal Documents

Internal documents such as project reports with plans and evaluations of a number of different IT infrastructure transformation projects within Telia was reviewed. This in turn to understand the characteristics of the typical project and to take part of previous experiences. To a varied extent, for example, whether or not the projects were still ongoing, the documents comprised full project plans including results and lessons learned. Some typical examples of reviewed projects with short outlines can be found in the *Commissioner* subchapter in section 1.7 in the *Introduction* chapter. The intention was to review the projects with the most available information from interviewees and documents, which resulted in the presented examples. All the documents were sent to us by email from project managers and our supervisor at Telia. Besides, general-context company specific agile models and approaches were studied through the intranet to follow Telia's journey to become an agile organization.

Semi-Structured Interviews

To understand the challenges and discover room for improvements by agile implementation in IT infrastructure transformation projects, interviews with both internal and external informants were conducted in this study. Collecting data through interviews is one of the most common ways of gathering data in qualitative social science research (Blomkvist & Hallin, 2015). The interviews acted as the primary source of empirical data and followed a semi-structured shape. The semi-structured interview style is also the most commonly used approach when conducting interviews (Blomkvist & Hallin, 2015). By carrying out semi-structured interviews with questions focused on

some topics, new dimensions of chosen but also additional topics within agile could be identified and resulted in richer empirics and conclusions.

The interviews were conducted in two rounds. The first round of interviews was made in the initial phase of the study with a few internal candidates with positions as senior manager and project manager to better understand, identify and define the problem. Blomkvist and Hallin (2015) recommend having interviews in the beginning of the research process to simplify in defining the problem of the investigation. The material from the internal documents acted as the foundation of the interviews but also overall experiences of the interviewees related to agile and IT infrastructure were discussed with the interviewees.

In the second round, more internal interviews as well as external interviews were conducted, in total 14 interviews. This time, it was regarding their experiences and thoughts about agile implementation and the execution of the projects, intentionally to detect the difficulties and potential solutions of this. In this round, inputs from earlier interviews were dug deeper but also more aspects of agile related to the chosen frameworks and organizational functionality was in focus. Besides, the questions were framed according to the interviewee's position and expertise.

The internal interviews were in total held with 12 employees with different positions such as project manager, senior manager, change coordinator and technician from the two concerned departments, IT Infra and IT Ops. Thus, to cover most of the affected parts and people of the projects and provide the whole picture of the problem. Additionally, an interview with a network architect from the Network department which is one of the most leading departments at Telia when it comes to agile. This to capture Telia's situation and progress of their agile journey from the bigger picture. Nevertheless, the network architect had to deal with IT infrastructure as well. Thus, provided us with valuable insight relevant for the purpose of the study. The internal interviewees were picked by recommendations from our supervisor and other Telia employees, who also assisted with contact information.

The external interviews were conducted with three interviewees outside of Telia with many years of agile experiences to complement the study with insights from state-to-art research and additional real-life context. Two of them were involved in a global agile promoting organization, one with a postdoctoral background in software engineering and the other was a software developer CEO and previous board member of the agile community referred to. The third interviewee had specifically consulting experiences of implementing agile at scale in the banking industry with similar challenges as Telia. Based on their knowledge and long-time agile experience within different areas, involvement in the agile community and familiarity from similar projects, we considered the candidates relevant for the study. Specifically, we believed they would provide the study with diverse data of the investigated phenomenon. The external candidates were found through the global agile organization and recommendations by contacts. They were contacted and requested by e-mail. However, more than 20 other relevant external candidates were also contacted but with no answers or other reasons for not being able to participate in the study.

Each interview session with each candidate lasted for 45-90 (typically 60) minutes and was recorded with their permission. This to be able to go through the interview afterward and prevent any

misinterpretations. The majority of the interviews were held face-to-face but some of the interviewees were also located in other cities and countries. Hence, some interviews were made through Skype video call or ordinary call. In total 17 interview sessions were held, where the IT Infra Transformation senior manager and our supervisor with a project manager title at Telia were interviewed twice. During the thesis work, an organizational change was made at the investigated department. Thereby, two IT Infra Transformation senior managers were interviewed. Blomkvist and Hallin (2015), states that some institutes have a rule of thumb of having 10-15 interviews, but it depends on the quality of the interviews. At a point, a feeling of "saturation" will hit. In our case, all the interviewees gave us valuable information as they mainly held different positions. However, we did feel "saturation" after 6 interviews with project managers and decided to not have any more of them. Thus, the last interviews were used to confirm and reinforce the findings but also a chance to ask about further questions which had emerged as well as clarifying things. Besides, we could discuss our ideas and recommendations for the model at the last sessions with direct feedback. In this way, we could improve the content of the agile model.

The internal and external interviewees with their belonging department or division and title can be found in Figure 5 and Figure 6.

Internal Interviews		
Interviewee	**Department**	**Title**
A	IT Infra	Project Manager
B	IT Infra	Project Manager
C	IT Infra	Project Manager
D	IT Infra	Project Manager
E	IT Infra	Project Manager
F	IT Infra	Project Manager
G	IT Infra	Senior Manager
H	IT Infra	Senior Manager
I	IT Infra	Change Coordinator
J	IT Ops	Technical Expert
K	IT Ops	Head of Shared Services
O	Network	Network Architect

Figure 5. List of internal interview candidates.

External Interviews		
Interviewee	**Division**	**Title**
L	Software Engineering	Postdoctoral Researcher
M	Computer Software	Software Developer
N	Banking	Agile Transformation Advisor

Figure 6. List of external interview candidates.

Benchmark

In the world of business, benchmarking is described as a "managerial tool that improves performance by identifying and applying best-documented practices" (Bogetoft, 2012). The endeavor when conducting a benchmark is to compare, copy and learn from certain products, processes or technical applications of competitors, best-in-practice companies or even other departments at the own organization to improve implementations. A benchmark can be parted in three classifications. One category is the referent, referring to internal, competitor, industry (likewise non-competitors) counting, generic (including other different industries) or global. The second category of a benchmark can be content-wise, meaning to target for strategic, functional, process, or performance. The last one is purpose of the relationship, where the benchmark can either be competitive or collaborative. With a competitive intention, an organization benchmarks with their direct competitors. In practice, this can be difficult since competitors might not want to reveal their insights. A collaborate way is more common, involving two or more competitors learning from one another by sharing its inputs (Wah Fong et al., 1998).

In this investigation, a benchmark study would be highly relevant and valuable to our research. This, since previous research about cases of applying the concept of agile into IT infrastructure transformation projects are scarce. A referent benchmarking was made with a well-established Swedish bank with years of agile experiences. Their situation with legacy IT infrastructure and the need to modernize it can be resembled with Telia. In the recent years, the bank has had great success with implementation of agile ways of working, particularly by using SAFe, when developing their IT department and transforming into new IT environments. By conducting an interview with an agile transformation advisor working with the bank, our intention was to learn from their experiences and success factors as well as how they have handled common challenges and what challenges they still have. In specific, we were interested in the agile methodologies the bank used to perhaps apply some of the content in our model. More information about the interviewee can be seen in Figure 6 in the earlier section.

3.4 Research quality

The quality of the study in terms of validity, reliability and generalizability as well as ethical aspects are described and discussed below.

Validity and Reliability

Validity indicates to what extent a study measures what the study intends to measure and the degree of the investigated phenomena realized in the result. Errors due to incorrect procedures, inadequate samples and inaccurate measurement weakens the grade of validity (Collis & Hussey, 2003). To prevent this, the validity of a study can be increased by formulating a clear research framework, using pattern matching and theory triangulation (Gibbert et al., 2008).

Primarily, validity has tried to be achieved by selecting an appropriate methodology considering the purpose and the research questions of the study. To validate the relevance of the chosen methodological approaches, they have been given a motivation.

Further, the interview participants were chosen based on their significance and knowledge within the field of research. In the conduction of the interviews, the interview questions were adapted to each interviewee according to its expertise and experience. This, to acquire as much insights as possible from every interviewee related to the research area. Since a qualitative approach was used with the intention to capture rich data and contextual understanding, the time span of the interview sessions was aimed to be set long enough to go in-depth in discussions. The inductive and abductive approaches set for this study enhanced the validity as well, by switching between theory and empirics to obtain new important input, ensuring correct content were studied according to the purpose of the study. Also, following a semi-structured interview approach with open and follow-up questions made by the intuition at that very moment can lead to positive effects on the validity. This because other perspectives and inputs not included in the scope from the beginning can be captured and added, fostering for additional relevant data about the investigated phenomena.

To avoid misinterpretations of the interview questions during the interviews, typical examples were used to better explain the question as well as follow-up questions to confirm our understanding of the answers. Furthermore, all the interviews were recorded with permission to afterward be able to review the material and validate the collected information but also the interpretations of it. This was done by transcribing all interviews and repeated listening. However, interpretations of the interview material may still have been made wrongly and thereby impact the validity negatively. For instance, a non-existent background within IT education sometimes made things and contexts hard to grasp.

Also, despite the interviewee's relevance to the study, the majority of the interviewees were candidates from Telia and therefore information might be biased. By being clear about the purpose of the study and assure anonymity of the interviewees, more validate answers were strived to be obtained. More specifically, triangulation was applied by combining internal evaluated reports, external interviews and research papers within the field to balance any biased information and cover vital areas within the research area.

To ensure quality and validity of the data gathered from secondary sources, peer-reviewed books and papers were used to the possible extent. Besides, the publication dates were considered with the strive to use the most recent sources. Since previous research within the studied area is limited, it was difficult to fully consider it.

Reliability, on the other hand, strives for the non-existent of random errors and brings up the significance of accurateness. Hence, the desired state is to reach the same results if the study was to be re-conducted by following the same methodology (Gibbert et al., 2008).

As a qualitative research, particularly with semi-structured interviews, is dependent on the perception and understanding of the single interviewee, it is hard to directly ensure high reliability in this study. By conducting several interviews with interviewees with the same position at the investigated department at Telia, the reliability in the answers may have been amplified. Yet, if the study were to be repeated, the same result cannot be guaranteed. Therefore, emphasis has instead been to strengthen reliability by describing the research process including the discussed topics from the interviews and the character of the interviewees. Still, in the possible extent to not reveal any classified information and to withhold anonymity.

Generalizability

Generalizability, also referred as external validity, implies to the extent the findings of a study can be covered in other cases or settings (Gibbert et al., 2008) (Collis & Hussey, 2003). There is two types of generalizability, statistical and analytical generalizability (Collis & Hussey, 2003). When conducting a case study, statistical generalizability can never be achieved. The result from one single case study cannot be certainly grounded valid in other cases, not even when coming across similar cases. Nevertheless, the result from a well-performed case study can be evaluated in analytical generalizability, indicating to what extent the findings can be applied to other cases (Blomkvist & Hallin, 2015).

Since a case study at Telia Company is used as the research design in this investigation, the generalizability only refers to the analytical aspects of applying the outcome of the study in other cases. The investigation is mainly based on company-specific information and internal procedures practiced at Telia. However, parts of the findings and conclusion could be useful for other well-established companies, not only limited to telecom companies but companies which are undergoing transformations of complex IT environments with the aim to become more agile. Since the agile model purposely is created for Telia, it might be limited in use to only them. Still, the given guidelines in the model could be helpful for other comparable cases, in particular at other telcos facing similar challenges.

Ethics

When carrying out research, it is expected of the researchers to act with consideration to ethical aspects. In order to ensure an ethical behavior during the research process, a code of conduct according to the Swedish Research Council for humanities and social science has been used. The ethical code covers four principles a scientific work is required to be followed as stated below (Blomkvist and Hallin, 2015):

- **The information requirement** – the purpose of the study needs to be explained to the people who will be studied, for instance when asking them questions to answer or conducting interviews.
- **The consent requirement** – the people intended to be studied must approve on to be studied.
- **The confidentiality requirement** – the collected material needs to be handled confidentially, meaning that the material should not be shared freely, companies/organizations perhaps needs to be anonymous and the interviewees should not be able to be identified by the research paper.
- **The good use requirement** – the gathered material should only be used for the purpose of the study which also must be described at the time of gathering.

All the four stated principles have been fulfilled in this thesis. To begin with, every interview was initiated with a short description of the intended master's thesis and its purpose. Moreover, all the interviewees were contacted by us, where mostly our supervisor at Telia recommended relevant internal interviewee candidates and helped with contact information at times. The interviewees were requested by email regarding their participation in the interviews with a brief outline of the master's thesis and the purpose with the study included. Further on, regarding the confidentiality requirement, both of us signed a non-disclosure agreement with Telia Company before starting with the thesis work. This was explained to the interviewees and their anonymity were promised, where only the title and department or industry should be left out. Likewise, before recording the interviews, we asked for the interviewee's permission first. Besides, this paper has been reviewed by the commissioner of the assigned master's thesis in order to approve its confidentiality. The last principle has been fulfilled by the mentioned aspects above as well as by only using the material for its intended purpose and nothing else.

3.5 Research process

The process of the research is demonstrated in Figure 7 with related descriptions in brief of each step in the following subsection.

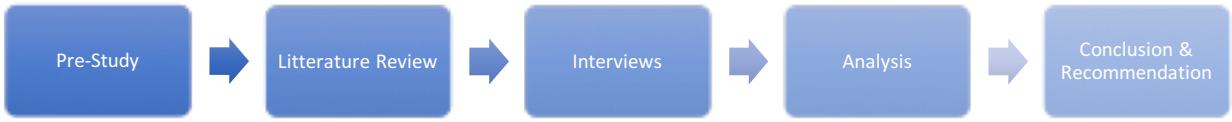

Figure 7. An outline of the stages in the process of the research.

Pre-study – To understand the company situation and the problematization, a pre-study was made. This implied information retrieval to read up on literature regarding IT infrastructure and agile management to get an understanding of the field. Further on, interviews were conducted with the senior manager of the department and a few project managers to get their input of the current situation at Telia and the challenges they are facing today.

Literature review – In order to create a customized agile model suited for IT infrastructure transformation projects according to Telia's needs we had to read up on different agile methodologies and principles as well as previous research related to the field. With inputs from the initial interviews, a comprehensive literature study was conducted simultaneously regarding various agile frameworks. A subjective decision was made on the theoretical framings which laid as the foundation for the creation of the model. The larger scope and restrictions of the agile model was decided in this stage, e.g. execution phase. At this phase, an inductive approach was applied where the insights from the pre-study interviews were to be reflected on by using the theoretical material gathered in the literature study.

Interviews – Internal interviews with key actors within the projects were conducted to detect the company challenges within the field of agile and IT infrastructure transformation on a deeper level and find potential areas to improve with the help of agile concepts. Likewise, interviews with external agile experts were conducted to get outside perspectives of the researched area. An abductive reasoning was used during this phase where partly theories and ideas from the literature were influenced by the empirical material and vice versa. This let us be more flexible to new valuable insights, adjusting the problematization to better match our findings and put it into the right context. A benchmark study was made to learn from a Swedish bank who has had success with agile implementation when transforming their IT infrastructure.

Analysis – The empirical findings were analyzed within different categorizations of themes and mapped with the agile principles and values as well as the selected agile frameworks to develop the customized agile model suited for IT infrastructure projects at Telia Company. Mainly, every category was analyzed considered the previous experiences, the current situation including challenges, potential ideas and improvements. Then, each category ended with a discussion referred to agile ways of working including recommendations. The analysis of the categories was made in the extent which was relevant to fulfill the purpose of the study and contribute to the case company's needs. Meaning that some of the categories were analyzed on a more profound level, while other categories were analyzed more synoptically.

Conclusions and Recommendations – Finally, the research questions were answered and the proposed agile model was created and discussed. The agile model was based on the findings and recommendations discussed in the analysis. In the proposed model, recommendations and guidelines are given to execute the IT infrastructure transformation projects in an agile way and facilitate to cope with the faced challenges. Further, recommendations on next steps and future work, both academic and managerial implications, were lastly given.

4 Empirics

In this chapter, the empirical data from the interviews as well as the benchmark study are presented in categories of different themes. Lastly, a compilation of the empirical findings is presented in a figure.

4.1 Interviews

Here, the empirical data from the internal and external interviews are presented in categories of different themes. In every category, the current situation including challenges, earlier agile experiences and areas of improvements as well as ideas are mainly covered. Each interviewee is referred to in the text with a given letter between A-M according to Figure 5 and 6 found in the *Data Collection* section 3.3 in the *Methodology* chapter.

4.1.1 The view on agile

What is agile?

As it was pointed out in the pre-study phase, it can be problematic but yet important to have a common view of the meaning of agile (Interviewee A, 2018). Therefore, this question was addressed among the interviewees. Among the project managers it was seen as a way of working small and divided (Interviewee E, 2018), a possibility to adapt the work according to prevailing situations (Interviewee F, 2018) and as something which might be packaged into themes such as making things smoother, faster and better, even if it has no meaning per se (Interviewee D, 2018). For Interviewee K (2018), agile is about delivering solutions with speed, collaboration and automation. Interviewee O (2018) rather stressed the concept of agile as a culture, how we relate to what we want to achieve and the crucial importance of having the agile mindset throughout the whole organization. External interviewees with agile expertise referred to agile as being lightweight (Interviewee M, 2018), the ability to handle change (Interviewee L, 2018) and as obtaining maneuverability in an organizational context (Interviewee N, 2018).

IT Infrastructure projects - agile constraints

Some of the interviewees pointed out what they believe are agile constraints in the IT infrastructure projects. Due to the IT infrastructure projects' relations with other things such as license agreements, LCM and other business activities, there are many disruptions which need to be planned for. Traceability requirements further limit the possibility to be agile (Interviewee E, 2018).

There are also difficulties in being agile when you replace a platform with another. There is a need to move all traffic to the new platform and thereby do a clean cutover, with a sharp deadline. This means there can be nothing left in the backlog (Interviewee F, 2018) and it limits the possibility of being agile in the project's scope. There is also typically a need, for example from the upper hierarchy management, to know what they will get (Interviewee G, 2018).

The infrastructure teams are also often very much dependent on external knowledge such as knowledge about applications and systems relations not inherent in the team, which makes it hard to be truly self-sufficient (Interviewee A, 2018).

The transformation of old and big legacy is difficult to do agile considering it often involves moving real hardware, sometimes in the same size as rooms. The fact that much of the competence of the legacy systems go into retirement does not make it easier. Furthermore, by having well-planned change processes which ensure quality in the IT landscape may affect the speed of doing things in the change process (Interviewee I, 2018).

Since the infrastructure transformation affects many different parts of the large organization, there will be big challenges to become agile due to organizational structural and cultural reasons. It is important with control mechanisms to synchronize different parts of the organization and keeping it together, but when implementing agile it often involves identifying and getting rid of unnecessary control mechanisms and lowering decision making authorities. This involves change of mindset as well as questioning people's identities, positions and authorities, which naturally will trigger certain resistance (Interviewee L, 2018).

Also, silo structured way of working in terms of having single individuals doing one specific task is an obstacle to becoming agile in IT infrastructure projects (Interviewee D, 2018). Interviewee O (2018) and Interviewee N (2018) means that the technical part of becoming more agile is not the issue, it is rather the mindset. Interviewee O means that starting to build in small steps, having continuous releases, automating testing and re-doing, thereby constantly changing in an agile manner and reducing the risk, is only extremely hard to realize because people do not understand the fundamentals of agile and persist to seeing to a big plan.

Adopting agile in large organizations - common mistakes

When large companies want to apply agile ways of working, it is common to make pitfalls on the journey. The superstition of the final result combining with time is one example of things people underestimate when wanting to become agile according to Interviewee D (2018). He continues saying that organizations want to apply agile ways of working with the belief of excellent outcomes in short time. Unfortunately, they also miss out that 80-90% of the improvements come from the people in the teams. Further, both the external Interviewee L and Interviewee M (2018) have had experiences of companies believing that it is enough to implement an agile framework to become agile. It is common that companies change the names of their processes, such as calling the meetings "daily standups" and the requirements as "backlog" instead. Still, they work as before without doing an actual change and hence no improvements are seen. Interviewee L (2018) continues saying that agile is about changing the organizational culture and implicates a different way to relate to the projects, which also is the most difficult to achieve.

4.1.2 Customer Engagement

IT Operations

The involvement of IT Ops in the handover phase has been poor and something that they should be able to do better (Interviewee G, 2018). When there has been a close cooperation the handover is typically not a problem. However, operations seldom have time, resources or willingness to be involved in the project and make sure that their requirements are met (Interviewee A, Interviewee G, 2018). The problem is based on the fact that the organization needs to prioritize incidents and crisis management, which decreases prioritization of project involvement (Interviewee D, 2018).

In some cases, which Interviewee G (2018) thinks is a questionable method, the problem has been solved by bringing in external consultants who do the basic operational work while some of the operational staff are involved in the project. Head of shared services Interviewee K (2018), who also has previous experiences as project- and program manager, says that he normally has 40-50% of his staff engaged in the projects. He means that it is simply a question about prioritization. There may of course be some cost concerns when requesting for consultants to backfill, but he does not see this as any major issue. He would rather have the operations staff hands-on in the projects when implementing a new platform, deploying it, testing it and so on, before bringing it to production.

Moreover, another project manager mentions how it is usually very appreciated when operations are invited to discussion meetings where they are informed about what is going on and where they are given the opportunity to ask questions (Interviewee E, 2018).

An external interviewee further stresses the importance of involving operations from the start and that it is too much short thinking by not engaging, considering that it will sooner or later go to IT operation's table anyway (Interviewee M, 2018).

Relating to team structure, Interviewee O (2018) mentions how handovers have become a real phenomenon in the organization. He means that it is important to have a team consisting of the same people who have been involved from the beginning, reducing handovers. He furthermore means that when a platform has been implemented, it does not simply stop there, but the same people who have worked with the implementation continues to release on the platform to keep up with new requirements.

Business Customers

Business customers can here refer to a varied set of stakeholders, such as business units or application users, application owners and system owners, etc. They are regarded as business customers, as infrastructural changes somehow affect them and the underlying performance capabilities. The changes may more or less directly affect them, which is why engagement naturally differs.

Regarding the communication with business unit customers whose orders are an important part of the project scope, a dialogue may be beneficial to create and meet the right expectations towards the customer. For example, in one project they started to involve a major customer in weekly meetings after they noticed that the customer wanted things that they had not previously included (Interviewee B, 2018).

As explained in the introduction chapter, business customers are affected by changes done in infrastructure projects even if they are not directly involved in the project. According to Interviewee B (2018), sometimes affected business customers do not want to cooperate when doing change work in the project. There is a misalignment about what is considered most important at the moment. For instance, application users or system owners may argue that they do not have time for changes and therefore it gets hard to get a service window. In that case, escalations may

have to be done during steering group meetings and then the representative of the steering group might have to talk with their managers or business units (Interviewee B, 2018). Interviewee C (2018) also states that the system owners often know more about the budget than the actual technology of a system. Bottom line, they primarily care about the performance of their systems.

Relating to what is described above, a frequent source of slowed down transformation work is "incidents caused by change" - for example if a server does not start again after a reboot and there is no technician in place to immediately address the situation, thereby causing a stop for several customers' systems - results in impaired confidence for the infrastructure project from the business customer side. These incidents are rare, but when they happen, they may affect several systems. For example, in Project C, four incidents have occurred out of thousands of migrations. However, this still means that it becomes much harder to be allowed to do changes, and errands may have to be escalated to different control groups and so on. Much more time-consuming communication and meetings are then needed to repair the trust (Interviewee I, 2018).

Also, it may be hard to convince business customers about the benefits of the transformation work, if they do not gain any direct economic benefits themselves. For example, if the reduced operative costs following the project are realized in another part of the organization. Then you may motivate the transformation work's benefits to these business customers by increased security, operational capacity or speed, for instance. Part of the problem is also the divided organization where you have system owners in one part, technical operational staff in another, the infrastructure side and project leaders in another. Thus, there are many parts of the organization that need to collaborate, and it often involves many different countries too (Interviewee I, 2018).

It depends on the project, but in some projects, there can be strong dependencies of knowledge not inherent in the project teams to do certain change work, such as system and application relations analyses, before being able to continue. If the business side, who has the resources with the needed knowledge, has another time schedule in their heads and prioritize other things, this becomes a big source of project delay (Interviewee A, Interviewee G, 2018).

Even if a lot has been done in recent years, Interviewee D (2018) thinks that there is still room for better internal marketing towards business customers. This includes announcing things, such as the value contribution to the firm that comes with the change work. This should be done more. It can be done over some marketing channel, such as web or video, where stakeholders and customers are. There can be continuous workshops for this, but mainly, Interviewee D experiences that there are too few meetings with system owners on IT system and server level in the organization. Interviewee F (2018) further mentions how a sales script can help project members from different work streams to inform affected business customers about the changes being done and the benefits of them.

4.1.3 Alignment with Business

According to Interviewee A (2018), there is a need to have a closer dialogue with the business side. In an ever-changing environment, there needs to be a dialogue about what is happening around us that we need to be able to support. The gap is way too big in some areas. This may result in solutions not living up to the requirement picture or that projects do not get the right prioritization.

Interviewee D (2018) also experiences that there is a lack of representation and engagement from the business side in the infrastructure related projects once they have been started. It needs to be clearer who represents the business' interests, judging the delivery. He further implies that the time has come to seriously start working with development from the infrastructure side and aligning with operators and users of software.

In order to get a more common agenda between IT Infra, IT Ops and business, the head of Global Services and Operations (GSO) has a new idea of taking the role of the corporate group and operate this matter. The vision is to have a global steering function for all countries (Interviewee I, 2018). According to external Interviewee L (2018) it is very difficult to achieve a common agenda. He points out that the agenda will always be separated, but points out that a lot of communication and to discuss early is the best way to achieve common goals and agendas. He has never seen an example where there has been too much communication. From a project manager's perspective, Interviewee C (2018) describes the most important job as communicating the goals, securing that everyone has the same view and understand their role and responsibility related to the different deliveries in the project.

Furthermore, Interviewee K (2018) has a vision of being more proactive in non-standard infrastructure deliveries. This may be done by involving a solution manager who has a close dialogue with business units to see what is going on in the market and forecast demand for infrastructure services. You may then make preliminary approvals of budget frames. When the request actually comes in, you are ready to go. Proactive forecast activity can also help to manage supplier bookings. These things are starting to come in now.

4.1.4 Alignment Between Development and Operations

DevOps

Many interviewees named the concept of DevOps as a way of establishing a closer cooperation between development and operations.

Interviewee O (2018) states that there are bizarre amounts of technical debt in the organization. He means that this is a concept which is not even understood in the organization. The reason for this is that there is no continuous work with the implementations which has been done. The work is done very reactively. Old hardware components are looked for at eBay when the equipment does not work anymore. It is a must to go the DevOps way and stop building technical debt he adds.

DevOps is trying to be done more now, but has had less focus lately (Interviewee C, 2018). This includes involving operations and securing the operational competence and readiness in the development process. It is too common nowadays that technical debt occurs due to lacking compliance from the business side's requirements of performance, availability and capacity when new systems are released and deployed to production. Interviewee C means that this is mainly due to the fact that many IT organizations today still work in silos.

Regarding infrastructure services, it is about understanding the whole end-to-end value chain, including the role of suppliers. It can be quite complex, and this is the tricky part. Interviewee D

(2018) means that the maturity level of working agile in infrastructure delivery is low due to the silo-based structure of the organization, including a silo-based infrastructure function. There is a long way to go before being able to break down these silos. The agile way would be to be involved in all deliveries during the period and have competencies within the teams which overlap many functions, such as pulling cables as well as installing operating systems for instance.

At an organizational level, Interviewee N (2018) means that the real issue is not how teams work agile on team level with their specific deliveries, but how to bridge the gap between development and operations. There needs to be an agreement on the relationship between continuous operations and development in order to reach mutual understanding about what is the cost for pure quality. Thus, understanding how the infrastructure work and architectural work you are building are important parts of the shared responsibility for quality.

Interviewee K (2018) strongly believes that applying DevOps is a key which will stimulate becoming more agile in short-term and medium-long term. DevOps has been applied to certain dedicated areas in the organization, such as cloud. However, the majority of what Interviewee K handles is legacy. He and his management team are currently in the process of finding ways to becoming more agile and applying DevOps with regards to the legacy and enterprise aspects. They are talking a lot with different stakeholders of the organization to understand requirements and taking in architectural solutions from the client perspective.

Automation and Testing

One of the most frequent outcomes of DevOps is about continuously standardizing and automate processes to improve cycle times and realization of business value (Interviewee K, 2018). The operational processes, including patching of machines, is pursued towards becoming automated. Automation is an area which Interviewee K is really keen on with regards to being agile. The journey towards automation is something which has a strong focus and which they are working on.

Interviewee O (2018) means that there is no automated testing anywhere and no activities to get started with it. People even have difficulties in understanding the need for it. The testing today is manual and furthermore, the testing is very simple, such as testing if the charge for calls is working. The testing needs to be more qualitative, including testing of non-functional requirements. The testing needs to become automated and much more frequent. Today, testing occurs very seldom. The machines should basically run non-stop as long as there is no requirement which requires them to not run. Interviewee D (2018) mentioned how the project he is currently involved in would have benefitted by a proper test process and is convinced other projects would benefit from that as well.

Interviewee I (2018) also points to the journey of automating environments in order to enable for agile ways of working, including the possibility of being agile in the infrastructure projects. More than 50% of the equipment today is for sure stand-alone machines missing redundancy, where you cannot make changes without causing operational disruptions. Moreover, the systems may have requirements of manual testing and installation and thereby preventing an automated, agile process. The old stack of infrastructure therefore needs to be replaced with a more modern stack to allow for a much more agile landscape. This transformation, however, is not agile.

4.1.5 Suppliers

Late deliveries in the projects are very common, slowing down project progress (Interviewee B, 2018). Then you try to start with other things and depending on if it is an internal or external supplier, you might escalate in different steps to get deliveries faster. The steering group may help when there is a need to escalate Interviewee B adds.

External Interviewee M (2018) names two methods of becoming more agile in the supplier delivery aspect, which he has applied for both small and big deliveries. However, it may not always be possible but certainly in many cases he says. The first method is set based development which involves being transparent and including with for example three suppliers. Each supplier gets to deliver a certain part each, but depending on quality and speed of delivery, the ratio between these suppliers may change to a higher for instance. Another way is what Interviewee M calls real options. This is about investing in the possibility to get something delivered from a supplier. Here it is important to have a continuous dialogue with the suppliers since you are able to cut the deal at any time but they still get paid. This could be much more expensive, but may be worth it in some cases.

Furthermore, Interviewee O (2018) mentions how it is common that suppliers do acceptance testing of their equipment installations and integrations while internals just stands by and look. He means that there must be a more independent testing approach regardless of what is delivered. Then, there can be many suppliers too, who can build up modernized environments.

4.1.6 Team

Team characteristics

According to Interviewee L (2018), a major key to success in agile teams is to create cross-functional teams consisting of different functions from the organization. In this way, a proper understanding of the different departments will be gained as well as the team being more self-organized. Also, the tasks can be broken down in between the teams instead of being divided within different functions. Hence, the more you can create cross-functional teams with dedicated team members rather than having a resource pool of fixed technical competencies being continuously distributed around, the better.

On the other hand, if the strive is to make the deliveries more agile meaning shorter lead-times between people, the silo-based way of working may still work (Interviewee D, 2018). Some sort of grouping or function is necessary with regards to cost efficiency. Having one person doing everything at a company is not cost efficient. However, there will be higher demands for understanding and synchronization between deliveries and handovers in between the different groupings and functions. Interviewee D thinks that the silo-based way of working with strict emailing and ticketing systems will be erased more and more. He says that there is a long-time horizon, perhaps 10-15 years, before silo-based way of working will disappear. Interviewee J (2018) experiences that there have been stricter provisions lately, regarding what certain roles and units are supposed to do and with regards to the flexibility to interweave with other units.

The desirable scenario is to have teams that are fully self-organized, but team resources' abilities to solve problems and deliver will always differ. Therefore, project manager Interviewee C (2018)

adds that you need to secure that the team is functioning and delivering by following up their progress. You cannot just give away a task and believe that everything will be solved. That is why Interviewee C has continuous status reporting in all tasks. Moreover, the responsibilities of each project member cannot be formally written somewhere, but needs to be communicated by clear leadership (Interviewee D, 2018).

The storage project has been perceived as successful among interviewees with regards to teamwork, engagement within the teams and communication (Interviewee B, Interviewee J, 2018). Interviewee J means that key factors are competent resources within the project and that a lot of the information channels are built around personal contacts. For example, they have personal contacts at the external collaborative partner company delivering equipment. This supplier prioritizes the project highly and responds immediately. In other projects, Interviewee J has experienced delayed project progress when the feedback loop is slow. Then you may have to nag and escalate to managers.

Resource Allocation

To improve the communication within the team and consequently becoming more agile, a key is for the team to be stable for a long-time period. By moving around people, particularly people with technical competence, working a little on different projects, a lack of team belonging will arise (Interviewee L, 2018). Interviewee O (2018) further stressed the benefits of having a stable group of people who are involved in a new platform implementation process from beginning to end, thereby reducing handovers. Also, for them to continue being involved in the platform and continuous release of new requirements for the platform even after the project is finalized.

According to the external Interviewee L (2018), shortage of resources in some parts of the organization is a huge problem but its effect is not mentioned in reports or research. This is a recognized challenge among project members at Telia, who explain it as a continuous fight (Interviewee C, 2018). Resources are estimated and secured before project starts, as well as continuously allocated between different projects throughout their timespans. At IT Infra there, is a weekly resource meeting where resource allocation is discussed together with all the project managers. This works quite good but the most critical or skilled resources are often overbooked (Interviewee C, 2018).

When allocating new resources during the project, they are taken from the line organization and are not fixed project resources (Interviewee I, 2018). One project manager names the fight for line resources as one of the most common reasons for delays in projects (Interviewee F, 2018). Another project manager means that operational managers probably receive requests from 20-50 simultaneously on-going projects that all need some kind of function to be delivered from their technicians. He means that it is really hard for these managers to know how important a certain delivery is. Thereby, Interviewee D (2018) thinks that in order to improve effective errand management, the way the importance of certain deliveries is visualized could be improved. It comes down to clarity about demands and prioritization.

Regarding allocated project resources in general, Interviewee F's (2018) experience is that teams are much more effective when resources are allocated full-time for the project, including the role as project manager. When resources are allocated part-time it also typically means that the resources

are more physically distributed, which makes it harder with communication. When bringing in consultants, they are typically allocated full-time for the project. But this is often expensive according to Interviewee B (2018) who also adds that it takes more time since the consultants need to get going in the projects.

Interviewee D (2018) also states that the idea of being agile is that a person can do many things in a project, which advocates full-time dedication to the project. However, an external interviewee contradicts this view on full-time dedication and means that greater flexibility and resource utilization can be reached if everybody starts booking their resources at a maximum of 50% instead and leave some room in their calendars (Interviewee M, 2018). Another project manager means that his attitude is to not lock his resources. He means that there are days when they might not have much to do in the project, and in these cases, it is better that they work elsewhere, where there is currently more to do. He might need their full-time dedication at a later stage instead (Interviewee E, 2018).

Roles

Interviewee F (2018) believes that infrastructure architects are key to succeed with infrastructure projects. It is important to see the whole picture. Since 2017 and 2018 there is an architect involved at IT infra. Furthermore, a role that Interviewee D (2018) misses in the teams of smaller projects is a person with proper competence within the area of the delivery to facilitate between technical project members. A person who leans towards the technical project leader role with the right knowledge and personality. In theory, the role could be called scrum master, someone who can manage to get people working together. Because, this requires a specific personality and role to make this work in practice. In the larger projects, the need for a technical project leader is important since the project managers will be too busy with stakeholder communication and other activities.

Interviewee L (2018) points to the importance of prioritization, which is typically the Product Owner's responsibility. However, Interviewee L has seen at many organizations that it is common that the Product Owner is responsible for many teams and their backlogs. This makes it difficult to collect and process all information and thereby prioritize in and between the teams effectively. They have too much responsibility and thereby become bottlenecks. A solution is to create a representative group consisting of people from different units who have a more organizational strategic overview. This representative group will then have to re-prioritize before each new sprint.

4.1.7 Meetings

According to the external Interviewee L (2018), it is important to be clear in what way to communicate. The meetings should not be enforced, the team should decide if it is necessary or not. In that way, self-organized teams will be developed. The best example he has seen is when the team is enforced to create a process, where there are best practices to choose from, but when they decide themselves. In this way, the teams naturally create a good meeting and communication structure.

Another external interviewee also argues that meetings along with other ceremonies standing in the way for productivity, should try to be held at a minimum (Interviewee M, 2018). Internal Interviewee J (2018) experiences that there are many meetings where many of the participants'

presence is irrelevant for the meeting, just to make sure no mistakes have been made and that all information has reached out to everyone. He did an estimation that 15-minute morning meetings which do not concern him at all, responds to 10 weeks of work each year, including the time it takes to get to the meetings and get set up for them. He means that this is time he could have spent on producing value for customers. Furthermore, he points to the tendency in Sweden, that the same issue is passed around and discussed over and over again before a decision is made.

Interviewee D (2018) also expresses experiences related to this. He means that in general, he thinks there are too many project meetings. Moreover, he believes in short, effective meetings where extra room should be given after the meeting for people who want to discuss things further not concerning everybody. He added that the retrospectives are other occasions where people can talk and exchange ideas. Lastly, Interviewee D points to the benefits of agile, by having guidelines about who is supposed to talk and participate in certain meetings and forums. Thereby avoiding long-spun debates and actually focusing and deciding on next steps.

Further, several interviewees pointed out the benefits of having meetings face-to-face. Interviewee C (2018) states that the most important principle when it comes to utilizing agile principles in terms of planning is to have face-to-face meetings.

As it is now, there is no outspoken meeting structure or best practices to follow in the projects. The number of meetings in every project differs. For example, in the project Interviewee B (2018) is managing, they have a status meeting with the internal project team every week where they discuss the status of work and what to do next. Also, a status meeting with external partners takes place on a weekly basis, where even the customer now is invited to manage expectations and uncertainties. Further, remediation meetings about system migrations are set to every week. Every other week, a project steering group meeting takes place. There are also some unfixed meetings. Outside of the frame of the specific projects, IT Infra steering group have a meeting every other week to manage progress and issues in the Infra projects, where the project managers participate and report on the statuses of their projects.

4.1.8 Continuous Planning

During the course of the projects, it is common that new things arise, causing a need to re-plan and make changes (Interviewee B, Interviewee D, 2018). Interviewee B further mentions that she believes it may be quite common that accelerated decisions are made due to set timeframes, which may later cause a demand for re-doing things. In the project she is currently involved in, an accelerated negotiation resulted in that some important details were missed out, which caused delays later on in the project when things had to be redone and new things needed to be ordered.

It is common that there are dependencies within the projects, meaning that certain technical work is dependent on other people's or group's technical work. A project manager points out the tendency that different groups may "point fingers" at each other when there is a need for efforts from multiple groups. From her experiences and observations, she believes that there is room for improvement in the way different groups' and people's activities are synchronized and how common milestones are set up. She believes that there are opportunities to "throw away department hats and instead put on everybody's hats" and think more of the project. She believes

that more physical presence together could facilitate to achieve this and to become more agile. She also believes that more frequent planning and evaluation meetings where you together look at what you can achieve the upcoming week or so, and then follow it up, may help in this matter. She has attempted to set up technical meetings to facilitate the communication between different groups and people. Even if this attempt failed, she believes this could work (Interviewee F, 2018).

Regarding dependencies on deliveries from internal and external partners that are needed to continue the transformation work, it is not that crucial according to Interviewee D (2018) as long as they are known in the beginning. However, project manager Interviewee D (2018) means that it is frequent, probably in all projects, that new information gets received at a late stage, when an execution decision has already been made. This is because knowledge and demands at the company are so scattered. He means by his experiences that an agile approach works excellent in the attempt to counteract this. Then you have an opportunity to do a small re-planning and avoid extensive change requests where the whole management has to be involved. The key is to bring knowledge together from different areas, integrating them into a team and getting these people to really communicate with each other. To succeed with this, Scrum meetings tend to facilitate. They create personal chemistry between team members which fosters discussions and which clears out questions of issues. Smarter ways of solving things and thereby better investment decisions are made. By pulling together teams this way (who may even be geographically distributed), putting pressure on them to deliver something and to deliver it within a certain timeframe, this collaboration is basically created automatically. A precondition is that people like to talk with each other. In this way, Interviewee D means that he has reached improvements and results in his projects, even if control groups may sometimes be confused when new things arise the day after starting an execution phase.

In a large data center transformation program, the planning worked really well. They had weekly planning meetings when they planned what activities would be executed (Interviewee E, 2018), along with planning meetings before each 4-week sprint to see what they would be able to do in the upcoming sprint (Interviewee A, 2018). Interviewee E further points to the use of daily short morning meetings within the teams, when you ask few and short questions such as "What can I do today and what prevents me from reaching my goals?". In this way, everybody gets the chance to deliver based on what they can actually do and the work becomes proactive by finding hidden obstacles. He further means that it is important to break down larger problems into smaller, manageable packages.

A project manager stated that it is hard not to get any scope creep when you are running projects that last for longer than one year. The reality changes in the background while running the project. He points out that there is not really such a culture at the company where you periodically question the scope. He thinks that it would be good to meet with all the stakeholders and the steering group, perhaps once every quarter, to discuss what value the project will bring and steer the course accordingly. However, the opinion between colleagues differs with regards to having these kinds of scope reviews (Interviewee E, 2018). Interviewee G (2018) thinks it is dangerous to be too agile with the scope of these projects. He means that the scope needs to be very clear when initiating the project and that you cannot make it up once you have started. However, the technical realizations are hard to know exactly and may therefore give the course of the project some

flexibility. While things are sometimes added to the scope, the most common is that the initial scope is successively shrunk.

4.1.9 Visualizing

An external interviewee believes that visualizing is the key to quick understanding between groups and individuals. He refers to the use of dependency diagrams and believes that the communication channels and the distance between people is the greatest obstacle in utilizing visualizing methods (Interviewee M, 2018).

To follow up the process of the project figuratively, there are applications and internal templates to utilize (Interviewee C, 2018). In the large data center transformation program, visualizing boards were used to see where in the process they were and to manage the work stream. Even if the ability to be truly agile were limited by other factors such as dependency on application knowledge not inherent in the project teams, this resulted in fine progress in different areas along with the sprint planning and retrospectives (Interviewee A, 2018). Another project manager refers to his experienced benefits of a reasonable use of burndown charts to visualize how many of the deliveries that have been handled and to see how much in phase they are in relation to what they should be. He further means that visualizing boards of different kinds work even if team members are geographically distributed, but that it is much harder. These techniques work truly better, perhaps by a factor of 10, if project members are physically present. Furthermore, he has experienced that he has missed the right technical support and tools to utilize these techniques to the fullest (Interviewee D, 2018).

4.1.10 Project Related Documentation

Interviewee C (2018) just finalized an evaluation report for a project and needs to write three different reports to be able to close it in Telia. He does not think someone will look at it, maybe someone but it absolutely does not add any value he says. Of course, it is important with documentation from a control perspective in order to evaluate the outcomes of the projects, but too much documentation does not add any value Interviewee C adds. It is easy to document just for the sake of the matter (Interviewee E, 2018). Another issue pointed out is too much documents by email. Interviewee J (2018) gives an example of receiving 30 emails daily from different managers. The emails are a way to ”secure” that everyone has been given the information, but Interviewee J does not have the time to read them and wants relevant information in the right amount, concerning him.

4.1.11 Continuous Improvement

Processes

Interviewee I (2018) expresses how they work with improving their processes by evaluating several methods when initiating a project. One method will be agreed on and run, but it is seldom it will be strictly followed during the whole project. Small adjustments will be made continuously or even a total change of the project if things are not working out as expected. For instance, in a recent project Interviewee I was involved in, they re-used a method from an earlier project. However, when implementing the method, it did not fit properly and they decided to alter the working

method completely together with their external partners. It took them a couple of weeks but afterwards, everything has moved on perfectly for months. Yet, if any incidents occur, you adjust and make new decisions according to the situation. With other words, there are no problems adjusting the method along the execution of the project, it is rather something obvious in order to run a project smoothly he says.

Interviewee J (2018) has had previous experiences with lean implementation where ideas were raised by the technical project members. An attempt to raise three improvement ideas to a higher level every month was initiated but the initiative collapsed after a while and now the ideas mainly come from above. He means that there was probably a lack of personal engagement and confusion about whose touch point it is, resulting in that nothing happens. This could be improved by having some sort of responsible function or unit for following up these ideas, who needs to report back on progress regarding the idea, even if it means the idea is turned down. A concrete idea which Interviewee J has tried to raise multiple times is to have complete backup plans if any major accidents occur. If a system crashes, it will take up to two days instead of two hours to recover it. Interviewee J guesses that the damage must first occur before there will be any changes.

Another way to improve the processes is to continuously measure and trying to understand the results, which Interviewee D (2018) thinks is not utilized enough. The leaders may have collected tons of statistics and that is good, but it is not just about collecting data but to understand it. In Interviewee D's opinion, there are too little key performance indicators (KPIs) to follow.

Also, to streamline or automate delivery functions is something that needs to be focused on. It does not necessarily include improving an existing process but to understand the end-to-end flow and simplify it. In the delivery processes, one should think from the perspective of development and work in a structured way. You develop a process, test it, inform and educate about it before implementing it. To have this continuous workflow is something that is overridden today. Furthermore, he is convinced that in his latest project they would have benefited by having a proper test procedure before launching a new workflow, script or function to production. He believes that it applies to other projects as well. (Interviewee D, 2018).

In a large organization, it is important to standardize and have a lot of processes in order to streamline things. However, project manager Interviewee A (2018) sometimes recognizes a tendency that people hide behind the process. As soon as there is not a clear way on how to do something, it may result in that nothing happens. Interviewee H (2018) mentions that the biggest concern with regards to delays in projects and not-good-enough quality goes down to "it was not me". Meaning, that people disclaim responsibility and blame someone or something else for not being able to do what is needed. External interviewee M (2018) addresses this by stating that people will make things work despite the process and not thanks to the process. It is we ourselves who have imposed the processes, therefore it is also our responsibility to question them. Further, it is important to establish a culture where mistakes are not punished and to have open communications about what is going on (Interviewee L, Interviewee M, 2018). According to the external Interviewee L (2018), the management plays a huge role in setting an example here. By showing behaviors that you want to implement in the organization it gets clearer what is expected from the team members and how to act in these situations.

Retrospectives and Lessons Learned

In the project Interviewee D (2018) is currently involved in, there has been too much focus on the deliveries resulting in divergence in other areas such as retrospectives and lessons learned. In his earlier projects, the lessons learned have been set to the first Monday of every month, where people met face-to-face. They were very strict on the face-to-face part, people even traveled to participate in the meetings. Either one participated face-to-face or one did not participate at all, because agile ways of working require the personal presence. If you plan to become more agile in long-term, the retrospectives are a must according to Interviewee D (2018) and his experiences. He is convinced it contributes to great results. In the large data center transformation program, interviewees mentioned how they experienced improved results thanks to retrospectives. Interviewee E (2018) elaborates on this by explaining how the program came out as a totally different program with regards to improved processes, including reduced lead times.

According to Interviewee C (2018), learnings from previously succeeded projects are taken by reusing methods, processes and templates, specifically when running a similar project. However, Interviewee E (2018) explains the lack of a collectively shared lessons learned where all the information is gathered in one common place in a structured way with categories. He has to ask his colleagues in person if they have any experiences from similar projects, which he thinks will be subjective. Today, the lessons learned are written by various people in different ways and are not searchable. Interviewee D (2018) also experiences that it is hard to find information that he seeks. He agrees on organizing the projects in categories and after completing a project, the next project leader should be passed on the lessons learned from the same category. He continues saying that they are bad in taking advantage of other projects but thinks it is possible. On the other hand, Interviewee M (2018) states the power of storytelling, preferably in groups of three which allows for reflection beside talking, rather than documenting the lessons learned. Touching and relatable stories can be shared for example during lunch and develop strong problem solvers.

Individual Feedback

Lately this year, the individual feedback meetings have not been prioritized. In a recent program Interviewee D (2018) was involved in, they had face-to-face dialogues on a six-month basis with each project member. That is the only way to give feedback in the opinion of Interviewee D. The personal feedback can also be realized in other ways. Interviewee J (2018) describes how they nominate a hero of the month which stimulates the motivation and makes people feeling included. Interviewee J gives an example of feeling 120% taller by receiving personal recognition from a colleague, even if he knows sometimes the compliment is not fully true. Also, in cases where he has been doing things wrong, he has been told and received feedback. The external Interviewee L (2018) describes the worst scenario as when the project members do not know if their work is appreciated or not. To get feedback is a key in agile. Interviewee L continues telling that from a social psychological perspective, it is very destructive if one single person or some few persons get credit when the team performs well. It is seldom because of one single individual when handling this type of complex projects. To increase the trust within the team, it is important to give the team as a whole credit when accomplishing something.

4.1.12 Life Cycle Management

An external interviewee referred to LCM and liquidation of old systems as a key to be lightweight and thereby be truly agile (Interviewee M, 2018). Several interviewees pointed out the lack of a proper LCM at Telia. There is seldom a plan for the life cycle of the systems which means that they are often replaced too late, enforcing the business to work with poor quality systems until finding replacements (Interviewee E, 2018). It also happens that systems are classified as too complex and too expensive to liquidate (Interviewee A, 2018). Interviewee C (2018) gives an example of the billing system which runs on a longstanding mainframe that has been developed for ages. The cost of replacing it is too high and even the business risk, but the crucial part is its complexity. Besides, the number of people who have the knowledge to operate it is limited too.

There are projects aiming to update the information of existing systems and components along with other initiatives aimed to improve the quality and processes of LCM. One project manager perceiving the LCM history at the company as disastrous. He points out that the problem is not that there are no good initiatives to do updates and to do LCM, but the problem lies in securing funding for it. It is often more interesting to invest money in a new service that can give you more revenue than to put that money on LCM of legacy systems (Interviewee C, 2018). Interviewee D (2018) means that there is a missing integration between the infrastructure side who are replacing IT environments and the people who affect the systems, such as system owners. This results in that maintenance models are not followed and budgets for LCM not allocated. He thinks that the solution to the problem all starts with a continuous dialogue and internal marketing so that meetings start occurring naturally. Interviewee K (2018) also points to the fact that it can be hard to push system owners to be willing to upgrade their unsupported infrastructure if they do not see the value of it, considering it is cost.

Furthermore, Interviewee I (2018) points out that there is seldom a long-term thinking when connecting systems with different service windows and uptime requirements, service level agreements and other infrastructure requirements, to the same servers. He means that it would not be difficult to include this aspect when building new systems. It would make it easier to manage faster change work, not having to disturb someone else's customers. Typically, all affected application users need to agree on a service window when changes can be made. Interviewee F (2018) also points out the challenge of managing LCM activity such as doing updates, upgrades and patching, when system owners with different service windows are operating on the same platforms.

4.1.13 Documentation of System Configurations

As mentioned above and pointed out by several interviewees, poor LCM in terms of badly updated information about systems configurations and contact persons entails problems when transforming the infrastructure environments. This is a quite common dilemma and enforces the projects to chase people with the right knowledge, which can be hard. It may even be the case that systems do not have owners, or that the knowledge eventually gets lost, for example after having outsourced the management of systems to external suppliers (Interviewee A, 2018). Another example from Interviewee C (2018) which describes the issue regarding a business plan he is working on concerning a close down of data centers. Out of 335 physical objects located in the data centers, 40 of them were unknown items. Interviewee C continues saying that they have no clue what the

items are or who knows about them. Those resources have probably quit the company years ago. The last option is to plug the cable and see what happens. According to Interviewee I (2018), missing documentation is the main challenge to become more agile. If the information would be updated and reliable, work could be done much faster.

Another project manager expressed his understanding that system owners also have another job to do and might be owners of several systems, but thinks that there is reason to work harder with people responsible for LCM. For example, by having a certificate which states that the system has been handled and that the information is correct. In order for it to work, this is something that needs to be communicated as a prioritized goal from higher up in the organization (Interviewee E, 2018). An external interviewee stressed the importance of seeing the value created for yourself when doing LCM, though it can be really hard to achieve that (Interviewee L, 2018). By taking responsibility for your systems and making sure that the information is right, the root issue would be solved. However, people responsible for LCM is not always to blame. It may be the case that a handover might not have been smooth enough when someone retired, sometimes limiting the possibilities to do LCM (Interviewee F, 2018). Considering frequent organizational restructuring, it may not always be easy to know what your new role means and what is your responsibility, meaning it can be hard to get the information from the ones responsible on paper. Yet, Interviewee A (2018) thinks that the collective should have this knowledge.

4.2 Benchmark: The Bank

In order to see and learn from how IT infrastructure transformation has been done at other organizations where agile transformation has been perceived as successful, a benchmark study was made. The benchmark was conducted with a large, well-established Swedish bank. The study is based on an interview with Interviewee N (2018), who is working with SAFe implementation at the organization.

At The Bank, they have started to adopt the SAFe framework in parts of the IT organization. In these parts of the organization, the agile transformation is perceived as very successful on the team level, program level and the organizational level. In The Bank's case, this includes better alignment and understanding of the importance of small as well as major infrastructure transformation work. Furthermore, the timing of it.

Key roles within the framework with regards to infrastructure work, so-called enabler work, is the architects. On portfolio level, the enterprise architect and on program level, the system architect. They are responsible for envisioning the architectural vision.

One thing that is working really well for the alignment, is the program increment (PI) planning sessions which take place every 10-12 weeks. At the PI meetings, all stakeholders meet face-to-face and agree on a release train plan for all the stakeholders. The meetings bridge a lot of expectations, values and mindsets because it is obvious that there is a common goal when they meet and are all together. The release train is based on lean thinking, focusing on the end-to-end structure of delivery solutions for customer based thinking, thereby continuously optimize the business value of deliveries.

The SAFe organization is a learning organization which obtains better maneuverability in inspect and adapt loops. The idea is to constantly focus on what is most important for the organization. What has been realized, is that infrastructure changes and improvements cannot be postponed the way they have historically been, because of the technical debt which is too costly for the organization.

At The Bank, the current major epic in which most of the resources are spent, is an enabler epic which aims to address the situation of not creating good enough quality on the current platform. In the SAFe framework, the enablers are first class citizens in the requirement work. The general idea is to constantly build just enough of the architectural runway to be able to constantly build and change the business requirements on that runway. The relationship between the business and the transformation team are vital for this to happen.

The main idea is to move away from projects because they are an expensive way of doing changes, as they are expensive to start and stop, have a narrow focus which is repeatedly shifting for people and because they are constantly fighting for resources. SAFe is instead proposing to only have change teams which are constantly working from the constantly evolving and prioritized backlog. However, it is really hard to move away from the structure of projects completely. The Bank still have projects, which is causing some problems with two government structures running at the same time and which have dependencies of common resources.

The most difficult part of the transformation is how to understand leadership and management. A real agile organization is self-organized. For example, now it is not just the products that are being developed at the program level, but whole solutions for the whole organization. The product management at the program level will be actually responsible for implementing the strategy of the organization directly. The line management and the strategic management have to push down the responsibility for implementing the strategy down in the organization. This has turned out to be a really challenging transformation (Interviewee N, 2018).

Challenge	Elements of challenge	Consequences	Keys	Solutions
IT Ops Handover	-Time -Resources -Willingness -Prioritization	-Operative requirements not met	-(Early) Project Involvement -Dialogue/Informing -Consistent team	-Backfilling -Invite to meetings
Customer Involvement	-Expectations/Requirements	-Expectations/requirements not met	-Dialogue/Informing	-Invite to meetings
Cooperation from Business side when doing Change Work	-Differing agenda/prioritization -Trust -Divided organization -Dependency on business resources	-Slower project progress	-Better understanding of value contribution -Dialogue/Informing	-internal marketing -Sales script -Escalation
Business Alignment	-Lack of business representation -Lack of business engagement -Silo based organizational structure -Prioritization -Aligning infrastructure deliveries with business needs	-Low prioritization -Solutions/deliveries not meeting business requirements	-Closer dialogue with business stakeholders -Clearer business representation -Closer delivery alignment with other units and departments -(Early) Communication -Proactivity -End-to-end value understanding	-Global steering function -Involving solution manager -DevOps and frequent/automated testing -Cross-functional teams -Broader delivery involvement -SAFe (particularly PI planning)
Late deliveries from Suppliers	-Dependency for progression	-Slower project progress		-Set based development -Real options -Escalation
Team	-Self-organizing teams -Understanding of different groupings and functions -Workflow management -Team member abilities and behavior -Resource allocation -Knowledge not inherent in team	-Harder with communication when resources physically distributed and part time allocated -Synchronization shortcomings -Alignment shortcomings -Problems not solved/tasks not done	-Cross-functional teams -Team communication -Team stability -(Full-time) dedicated team members -Competent team members -Information channels built around personal contacts -Key role: Infrastructure architects -Key role: Technical project leader/teamwork facilitator -Clear) Leadership	-Organizational strategic representative group -Commonly agreed meeting structure/process -Scrum meetings -Face-to-face
Resource Allocation	-(Line) Resource shortage -Prioritization	-Slower project progress	-Clarity about demands and prioritization -Resource flexibility between projects	-Visualizing importance of deliveries -SAFe -Continuous resource meetings
Meetings	-Meeting structure/process effectiveness	-Irrelevant meeting participation -Too many meetings -Unproductive meetings (e.g. long spun debates, over-informative etc.)	-Few and short -Leave room for discussions after meeting -Guidelines on who is supposed to talk and in what forum -Face-to-face meetings	-Commonly agreed meeting structure/process
Planning	-Deadlines -(At late stage) New things/information arising -Synchronization between people's and groups' technical work -Scattered knowledge -Scope creep (e.g. reality changes when projects run longer than a year) -Balance planning with fast-changing requirements	-Accelerated decisions (later causing demand for re-planning) -Extensive change requests -Finger pointing -Extensive planning constraining agility	-Communication between people and between different groupings and functions -Frequent planning -Physical presence -Breaking down problems/work -Integrating knowledge from different areas	-Technical meetings -Scrum meetings (daily, weekly, monthly) -Scope review with stakeholders -Visualization tools and methods -PI planning -Frequent/automated testing
Continuous Improvement	-Within projects -Between projects -Delivery process -Business value perspective -Understanding results	-Lower motivation if people's potential not utilized -Lower level of improvement (particularly long term) -Not utilizing learnings from previous projects	-Re-use best methods from previous projects -Experiment and create best method within the project -More KPIs to follow (measure and understand results) -Automating and streamlining end-to-end delivery functions -Inspect and adapt -Team level and individual feedback -Forgiving culture	-Implement ideas from project members -Retrospectives (face-to-face) -Searchable and collectively shared lessons learned -Storytelling -Individual feedback meetings -Develop, test, inform, educate before implementat -SAFe
Life Cycle Management ***and Documentation of*** ***System Configurations***	-Lack of LCM planning -Complex and/or expensive liquidation -Operative knowledge (e.g. retirements) -Securing funding for LCM -Badly updated information about system configurations and people with system knowledge -Missing integration between infrastructure side and e.g. system owners -Systems with different requirements connected to same server/platform -Meaning of role and its responsibility	-Systems replaced too late -Maintenance models not followed -Harder to do updates -Detective work/chasing people with knowledge -Slower project progress -Technical debt	-Closer dialogue with system owners etc. -Work more with LCM and system configurations updating -Frequent continuous releases	-internal marketing -Start considering how systems with different requirements are connected -Make LCM and updating of system configurations a more prioritized goal from higher management -Certificate stating what has been done and overloo -Frequent/automated testing
Project Related Documentation/Information	-Unnecessary documentation/information	-Documentation not adding value -Too much documentation/information "drowning" project members	-Relevant documentation/information -Directed documentation/information	

Figure 8. Compilation of Empirical Results.

The figure shows challenges and ways to address them, according to interpretations from what was said in interviews. Each challenge involves a mix of the elements of the challenge and a mix of the ways to address the challenge. Thus, to clarify, each e.g. "solution", is not a solution to each "element" of the area of challenge.

5 Analysis

In this chapter, the empirics are analyzed in several categories and discussed in relation to agile theory in order to provide recommendations for agile execution of IT infrastructure transformation projects.

5.1 Life Cycle Management and Documentation of System Configurations

As an external interviewee pointed out, agile is about being lightweight. Central in this is about getting rid of legacy, which is very much what the main challenge is about with regards to infrastructure transformation at Telia. Another external interviewee also pointed out how history has taught him that postponing of infrastructural changes lead to technical debt which is too costly for organizations, thereby realizing that transformation cannot be postponed. The internal study at Telia confirms this realization and the fact that it may not have had the focus that it should have had. However, much of the responsibility for phasing out legacy systems and enabling an agile transformation comes down to system owners and other managers who are responsible for the systems and their maintenance plans.

"I guess this differs from company to company, but if you take Telia. Life cycle management in Telia has been a catastrophe." - Interviewee C

"We have bizarre amounts of technical debt. We do not understand that we are building technical debt. We do not even understand the concept of technical debt." - Interviewee O

What the study also shows, is that major infrastructural transformation work's conditions for agile execution become limited by non-existing and non-reliable information about system configurations and who to contact about them. While agile values oppose extensive documentation, the study identifies the organization as too large to be able to keep track of knowledge like this through personal communication channels. In this context, agile execution instead requires proper documentation. While there are now several initiatives aimed at improving this situation, the root cause of the problem is the proactive work in terms of doing LCM and making sure that there is existing and reliable information. Thus, this may still lead to future similar dilemmas, considering that there is still a lot of legacy and new legacy to come which will continuously need to be transformed.

What the study identifies with regards to this, is that there needs to be a close dialogue with the infrastructure side and the people responsible for the systems and environments. Relating to agile theory, this communication with stakeholders and customers is something which is essential. What the study identifies to address this, is that there is room for improved internal marketing towards these stakeholders, demonstrating the possibilities of LCM and the value contribution to the firm by doing LCM and updating information. This can be done through a marketing channel over the internal web and continuous workshops. The main idea is, however, to naturally initiate more meetings with system owners on IT system and server level through this activity.

Furthermore, the study identifies that LCM activity and transformation work may be done more agile by having better future thinking in the planning process of how systems are connected to different servers and platforms. This seems to be overridden today. Today, it is common that systems with different requirements on uptime and service windows are connected to the same server or platform, making it harder to do changes.

Lastly, prioritization of LCM and updating is very much a prioritization question which needs to be addressed by higher management. There may be a need to communicate this to the people responsible, as a more prioritized goal. An option pointed out is to let system owners and other responsible managers have certificates stating that they have gone through the system configuration information and confirming that the information is correct.

This study does however not have the full view of other activities which are conflicting this prioritization. Furthermore, the possibilities to do LCM may be limited due to systems who are missing owners, for example, due to retirements. Another reason may be unclarity about responsibility, due to frequent reorganization. Therefore, the handovers between owners and managers are also important, as well as clearing out responsibilities.

Above proposals are mainly facilitating in the long term, and have limited effects in the short term. More analysis regarding how to reduce technical debt and foster a continuous delivery of the right infrastructure components to align with business needs and operative requirements, will be discussed in *Business Alignment*.

5.2 Customer Engagement

As analyzed above, a close dialogue with business customers such as system owners and application owners may help to engage them in LCM activity. Considering that projects are also often dependent on them and their resources throughout project execution in terms of the need of analyses and to get service windows, the dialogue and internal marketing are important for this aspect too. Furthermore, project members may be facilitated in the communication process with these stakeholders and business units by using developed sales scripts stating why changes need to be made.

In the situations when there are major customers involved in the project who have ordered a delivery, the study recognizes that it is good to have a close dialogue from the beginning, to manage requirements and expectations. Informing and invitation to project meetings helps in this aspect.

Regarding IT Ops, the study recognizes that their involvement in the projects differs. In line with empirical findings and agile theory, the study recognizes the importance of this involvement in order to handover a solution which meets the operative requirements. The study also recognizes the benefit of trying to break down silos in this aspect, shaping a consistent team of infrastructure people and operations people who continue to have responsibility for continuous release within the new platform even after it has been implemented. As it seems to be today, projects seem to take care of LCM and requirements during the project phase, but after completion, environments seem to build up technical debt.

In line with this, the SAFe framework, discussed further down in *Business Alignment*, further addresses and facilitates the dialogue between infrastructure and their stakeholders. For example, it strongly emphasizes on the DevOps concept, integrating the continuous chain of operative requirements with infrastructure delivery and software development. Frequent testing of production environments occurs to synchronize the end-to-end delivery process and minimizing technical debt, where the testing is frequent and automated wherever possible.

5.3 Team

The study shows silo-based way of working as a reality at Telia. In order to become more agile, the silo structure must turn to more cross-functional teams. Groups or functions will still be needed, but strictly silos with no face-to-face communication will not last. This change in structure will likely be a long-term transformation. The cross-functional team construction with people from different functions from the organization is found to be a main key to succeed with agile teams, particularly with full-time dedication. This will contribute to better understanding of other functions' work and make the teams more self-organized. Furthermore, an aspect which has been found to be important in terms of better communication, is to have solid teams over a long-time period. Also, as mentioned earlier, having consistent teams that continue delivering new requirements even after project completion is important. Therefore, we encourage to have consistent and full-time allocated team members to the possible extent.

Also, in one of the studied projects which showed success in both teamwork, engagement and communication within the project team, keys for success were expressed as competent resources and communication channels being built around personal contacts. Having communication channels built around personal contacts is something which is much emphasized in agile theory. As the study identifies by the interviews, the mentioned challenges above can be addressed by the meetings structure according to Scrum. The Scrum meetings can help to build personal chemistry among team members from different functions and improve the communication between people. This, in turn, helps to synchronize work, finding the best solutions as well as discovering new aspects and hidden obstacles in a proactive way. Moreover, since problems are brought up to the surface, it will naturally prevent people from fleeing from responsibilities and giving excuses for not following through on different tasks. Further on, the realization of connecting teams from different units in synchronized organizational deliveries and build a closer relation could be done by SAFe, which will be discussed in more detail further down.

"Primarily, it helps me to have teams with competencies from different areas who actually sit and talk about things. Maybe, to some extent, it may not be the Scrum meetings per se. However, they always create questions and certain personal chemistry between people which makes them discuss things. Sometimes, they misunderstand things, but then you just solve it." - Interviewee D

In agile theory, a number of roles needed in agile projects are described. In IT Infra projects the required roles can differ according to the size and type of project. However, a key role in the larger projects which is expressed to be missing in the smaller projects, is the technical coordinator who can facilitate between technical project members. We think this specific role is a key role for agile execution and should be included in the projects regardless the size. The tasks and responsibilities

of a technical coordinator resemble in the role as a Scrum master, relating to theory. Another role which we identify as important, supported by agile principles, is to have someone involved in the project which represents the business' interests and has a lot of knowledge about the business needs. Whoever takes this role in the project, will have a clearer understanding of the business needs and how they should be realized in the project, by initiating SAFe structure. In SAFe, there is namely an ongoing strategy consensus among stakeholders. Since executing diverse projects, our suggestion is to define and allocate the needed roles including the tasks as well as responsibilities in the planning phase according to the requirements of the specific project.

5.4 Resource Allocation

As an external interviewee has pointed out to be common, it is stated to be a deficiency in resources, specifically line resources at Telia. A challenge for fighting to get resources among project members is expressed, which is also stated to be a common reason for late projects. A way to manage the allocation of the resources is done by having weekly resource meetings at the IT Infra department. These meetings have facilitated in this matter but still, it is hard to get hands on the most critical or skilled resources, particularly the resources from other parts of the organization. A challenge is to communicate the importance of deliveries in the projects to operational managers who lend out their resources. As was stated by an interviewee, there may be a need to improve the visualization of the importance of different deliveries to be clear about demands and prioritization. However, this probably requires some extensive analytical work in order to classify different IT systems and their components to better understand the business value of different infrastructure deliveries. Even if there may be a long journey towards establishing a landscape where it is always immediately clear about what should be prioritized, we believe that the SAFe framework along with its PI planning meetings is a way to go in order to continuously establish clearer prioritization and business value contribution of different deliveries within the organization.

To have allocated resources on full-time is mentioned as more effective in terms of collaboration, communication, progress and performance while distributed and part-time teams make these aspects harder. From an external interviewee point of view, better flexibility and resource utilization can however be obtained if the resources are allocated at maximum 50%. While project managers by their experiences were generally of the attitude that full-time dedication contributes to better success with the project execution, the importance of distributing the resources according to project status and needs within other projects, was also pointed out. As agile ways of working emphasize on the importance for individuals to feel motivated and interacting with each other, our recommendation is to allocate the resources on a level where this is met, preferably full-time. We furthermore recommend utilizing resources to a maximum by minimizing unproductive activities, which will be discussed more further down. In this way, there may also be better room for certain flexibility towards other needs within the organization. Of course, though, depending on the tasks needed to be performed by certain resources and due to resource constraints within the organization, there will also be project resources who can simply not be allocated full-time. However, the main point is that dedicated team members lead to more agile project executions.

5.5 Communication Practices

Meetings

Pointed out by some internal interviewees, the number of project meetings is in general viewed as too many. Furthermore, the content of the meetings may not concern every participant either. Instead, project managers advocate short, structured and effective face-to-face meetings with extra room for people who want to discuss further. Also, there is no shared meeting structure or best practice to follow today, rather the number of meetings differs and are up to the project manager to direct. In line with this, the study identifies a flexible, non-pre-decided meeting structure as an effective way of establishing the best kind of communication within the teams. However, as an external interviewee mentioned, it is very important with clearness in what way to communicate and the team members' involvement in deciding on the meeting and communication structure.

"I recur to communication. Relevant communication to the right people. I believe that is right. Not choking people with too many meetings"- Interviewee J

Continuous Planning and Visualization

As recognized in the empirical findings, it is very common with a need for re-planning throughout the projects. Some of the reasons for this may include hurried decisions due to set timeframes, new critical information coming up at a late stage due to scattered knowledge within the organization or because of lack of communication between different functions involved in the deliveries. More frequent planning and evaluation meetings together with different project functions are stated as beneficial to plan and follow up the upcoming time period as well as to discover hidden obstacles, find best solutions and foster natural communication and discussions between team members. One project manager believed Scrum meetings and regular retrospectives could be the solution to foster this communication and has had positive experiences with Scrum meetings in this matter. Other project managers also mentioned experienced benefits of working in 4-week sprints, having weekly planning and daily stand-up meetings according to Scrum. Other useful factors have been the use of visualization boards to facilitate communication, coordination and workflow, and burndown charts to illustrate progress in a simpler way. However, more technical support and tools for this is asked for.

"Then I believe an agile way of working fits extremely well. Then you have an opportunity to do a small re-planning without causing an extensive change request where the whole management needs to say their thing about the change." - Interviewee D

"I believe visualizing is the key to quick understanding between groups and individuals". - Interviewee M

Further, the empirical findings show partial opinions regarding the larger scope adjustability of the projects. Some believe being too agile on the scope is a big no while others desire for more flexibility and discussion during the progress of projects.

Recommendations

Based on literature and empirical findings, we recommend having short effective meetings where the project members have been a part of deciding the meeting frequency and structure to foster

self-organizing teams. The agreed structure may include guidelines about who should participate in certain meetings and who should talk the most in order to be effective. Meetings and communication between technical project members may advantageously be set up by a technical coordinator, a role which is analyzed previously. Project managers will easily have too much to bear with other stakeholder management to be responsible for this setup, which was for example identified in an interview where it was mentioned how there was a need for technical meetings. Yet, the setup attempt failed.

Generally, a meeting structure according to Scrum is identified as useful in order to be proactive, effective and to foster collaboration. Daily stand-ups including asking the three questions (what did I do yesterday, what will I do today, and what is getting in my way), weekly meetings with different project groups, retrospectives after finalized sprints including sprint review and planning is recommended. At the end of every weekly meeting, areas of responsibilities and corresponding action plan should be set to prevent the today's blaming culture. The Scrum meetings frequency and the execution process should be time-boxed which agile theory advocates. The time-span for the sprints may be adjusted according to what seems to work best in practice, but 4 weeks can be seen as a rule of thumb. However, as this study recognizes the benefits of the SAFe framework, it may be wise to synchronize the timespan of the sprints with other agile teams' sprint durations.

As stressed in theory and whose benefits are confirmed by empirical findings, agile is all about the individual and interactions, principally face-to-face. Hence, we recommend the meetings to occur face- to-face to the largest extent possible. When working with geographically distributed teams which often is the case at Telia, video communication is recommended. By having more full-time dedicated resources it may be easier to establish meetings with physical presence. By identifying important milestones, there may be certain time points in the project where the whole project team may benefit a little extra to be physically present together. For example, when there is critical work need to be done on-site by multiple functions.

Regarding dependencies and end-to-end delivery synchronization with other units, this can be realized through the meeting structure of SAFe in terms of PI planning sessions every 10-12 weeks, along with scrum of scrums meetings and frequent (preferably automated) testing along the program increments. This is further discussed in the *SAFe* section. For effective work breakdown structure, communication, coordination, sharing of ideas and process follow-ups, visualization tools such as boards, diagrams and burndown charts can advantageously be run with inspirations from Kanban. However, an increased organizational support and information about latest technology available, may be needed to succeed with this. Also, it is important to have someone who can set it up, tentatively the technical coordinator.

Furthermore, the SAFe framework naturally emphasizes a scope review every 10-12 weeks with all stakeholders, agreeing on the value contribution of continuous execution. One of the principles of agile, "responding to change over following a plan", suggests that it is important to be able to change the scope as the surrounding environment and requirements changes fast. In the larger infrastructure projects, which will require business analysis before approval, it may be hard to be too flexible with the scope. However, as they typically go on for a long time, we believe it is wise

to have a reconciliation every now and then to see if larger sets of business requirements have shifted.

5.6 Project Related Documentation

Regarding documentation, both a lack and overflow have been described. As discussed above, insufficient updates of LCM documentations such as system configurations were expressed which led to lost knowledge and time waste to look for people.

On the other hand, too much documentation seems to be required when closing a project and there seems to be a tendency to document just for the sake of it or being on the safe side. Also, excessive amounts of documents by email to technical project members throughout project execution is an expressed problem.

"I am doing evaluation reports now for a project that just got completed and I need to write down three different reports to be able to close it in Telia. I do not think someone will look into it. Maybe someone, but it adds absolutely no value." - Interviewee C

Here the value of documentation can be questioned, both by the part requiring it and also by the person who needs to document. As one of the agile values advocates to keep down the documentation, the value of the documents might determine the need for it. We suggest discussing the value of the documents, cut unnecessary documents and keep or add documents which bring value to the project performance such as system configuration documentation, or a structure lessons learned which can be reused. The goal is to keep it as limited as possible, without compromising with quality or necessary government and security pillars.

"People scoop out information in emails. Because then they are never to blame. But that is not it. I receive 30 emails every day from different managers, project managers. I do not have time to read them. If I would, I would not have time for anything else apart from gaining insight into organizational matters." – Interviewee J

5.7 Continuous Improvements

In the empirical findings, it is expressed that adjustments and improvements are made in a constant pattern during the project execution. Further, the findings show lack in taking advantage of process improvement ideas from technical project members where the ideas mainly come from higher levels. A responsible function who collects ideas and gives feedback on their realization potential and progress is requested. Also, statistics seems not be utilized with a shortage of key (KPIs) to follow. The importance of testing, informing and education during the delivery are also highlighted. A tendency of hiding behind processes when the way of working is unclear has been noticed. The external interviewees addressed the weight of establishing a culture where mistakes are okay and the management's responsibility for it.

The study shows that there can be a lack of retrospectives due to deliveries being more prioritized. Earlier experiences of strictly face-to-face retrospectives on a monthly basis was described. In other projects, improvements have been achieved by retrospectives. Overall, the study identifies that

great agile results can be achieved in the long-term by being more disciplined on monthly retrospectives after the end of the sprints and follow up that proposed changes are applied.

"In the data center consolidation program, we had retrospectives once a month. And there, I would say that we improved our processes. It was a completely different program going out than going in." - Interviewee E

"If you have a long-term strategy to work agile, then I see it as a must to have retrospectives face-to-face and I am absolutely convinced that it gives results." - Interviewee D

Today, learnings from previous projects are used but need to be more effectively shared in a structured way, preferably collected and searchable on a platform. However, an external interviewee also underlined the benefits of physical presence when sharing learnings from project to project. This is in line with what agile theory encourages. In a large organization however, it may be effective to have lessons learned documented, in order for people to easily find useful knowledge and best practices, and being able to contact the right people in a quick manner.

Likewise, individual feedback meetings have had lower priority now, whereas it was fixed on a six-month basis before in one of the studied projects. The study speaks for prominent value in terms of motivation and belongingness through individual feedback, not only for the single individual but also for the progress of the project.

Regularly reflecting on how to become more effective and then adjust accordingly, is an agile cornerstone mentioned in the principles. Retrospectives should be done face-to-face in a meeting structure after every sprint according to Scrum. A lot of the agile mindset is to continuously strive for improvements. Relating to this, the projects should be built around motivated individuals. They need an environment which fosters motivation and gives them support and trust according to the agile principles.

Thus, we recommend regular retrospectives, where the outcomes should be followed by due dates and responsible people to set improvement agreements in motion. Furthermore, we recommend initiating a responsible function for driving and follow up on realization of process and other improvement ideas (based on observations from technical resources) needing approval and/or investment from higher management. Raising ideas should be a continuous process to foster improvements as well as motivating individuals through personal recognition. Moreover, individual feedback sessions should advantageously be held every 6 months or so, to foster self-development and motivation. By implementing these recommendations combined with the right leadership, more self-organized teams will naturally be shaped, where people hide less behind processes and disclaim responsibility less. Moreover, since lessons learned from previous projects already is documented today, we see a value in structuring a shared, searchable platform for lessons learned from previous projects, which should not be too hard. Workshops should also be set up to transfer important practical knowledge and skills. Lastly, measuring KPIs should be facilitated by adopting the SAFe framework where the results of continuously improved aligned delivery processes can be better understood, for example by measuring the time it takes to roll out new business oriented services. Such increased focus on measuring has been identified in the literature to boost delivery process improvements.

5.8 Business Alignment

The empirical results bring forward a number of examples of how applied agile practices have led to improved results, as well as other situational examples of how agile practices may have helped. Furthermore, while interviewees have experienced improvements, there seem to be possibilities for further significant improvements, especially in the long term. This is if there would be more dedication to agile practices. However, while there are agile benefits to be reached by applying above analyzed practices in the projects, the study identifies that the possibilities of being truly agile in the project executions are limited by the surrounding organizational environment. For the projects to be agile, solutions for agile execution cannot simply be achieved by looking narrowly at the work methods of the infrastructure transformation project teams.

There are a few major areas of challenges which the study identifies with regards to this. First of all, while doing change work, the projects are dependent on cooperation from the business side to get service windows and/or resources from the business. The business side may not always have the same agenda with regards to executing the change work, thus limiting the agile execution. This comes down to the issue of prioritization.

"The business side did not see any value with it whatsoever at that moment. So, there you need to be in agreement with the business. Ok, when is it appropriate to do this? When does it suit you? Sometimes we may need to be a bit more demanding. But in that case, you need to be in a close dialogue and have a really close collaboration and I think that here, you need to think about the governing mechanisms. What is it that actually controls a common agenda for this?" - Interviewee A

Secondly, the gap in the dialogue with the business side with regards to what needs to be delivered, is too big in some areas. Infrastructure deliveries need to be aligned with business needs, and there needs to be clarity about business representation along with increased business engagement in the infrastructure deliveries.

"What I believe we have forgotten is that we should have a closer dialogue with the business in some areas where we have a way too big of a gap. We need to work together with the requirements picture. What is happening around us that we need to be able to support?" - Interviewee A

"There needs to be an engaged requirements specifier, or many, who represents the business side. I experience that there are way too few of them." - Interviewee D

Thirdly, the silo structure of the organization makes it challenging to synchronize deliveries with different units and departments within the organization. There is a need for closer delivery alignment with other units and departments, fostering an end-to-end value understanding and continuously improve and automate a broad delivery process.

"If I would point to an area, then I believe streamlining or automating delivery functions should have a higher focus than what it has today. To actually try to understand the end-to-end flow and make it simpler" - Interviewee D

Fourthly, there needs to be a higher focus on testing, which will need investments, in order to continuously make sure that the right IT infrastructure landscape is in place to support the business

requirements, thereby reducing technical debt. Furthermore, to not only test the most basic things, but initiating more advanced test procedures, such as testing non- functional requirements.

"There is no automated testing anywhere. No activities to get started with it. People even have difficulties to understand that it is needed." - Interviewee O

"In the project I am about to close now I am totally convinced that we would have benefited by a proper test procedure before launching a new workflow or a new script or a new function to production. I live in the belief that it applies to other projects as well." - Interviewee D

Lastly, there need to be continuous infrastructure requirement implementations within the IT environments, even after the project is closed. A consistent team which has worked with the implementation of a new platform during project phase may preferably continue having responsibility for it after project completion as well. If utilizing automated testing, the environments may be looked after and maintained without much effort.

"In a project which implements something we are active within the area of work. The project leaves behind some technical debt. Then, there is no continuous work with the implementation. To bring in new releases at all in order to be at the level where we need to be is not existent at all. We do not do any continuous work with the implementation we have done." - Interviewee O

These are challenges which the study identifies as the biggest challenges with regards to becoming truly agile in infrastructure deliveries, and where there are most opportunities for improvements. The study identifies the SAFe framework as an agile framework whose structure corresponds to solutions with regards to these challenges and many of the other challenges identified in the study. The framework also contains a strong emphasis on DevOps, automation and continuous testing and release, named among many interviewees as important directions to go towards with regards to becoming agile.

5.9 SAFe

By bringing together relevant business stakeholders and teams from various parts of the organization every 10-12 weeks (corresponding to every 4-6 sprints in the theoretical framework) for a PI planning session, great conditions for end-to-end alignment can be created. The PI planning session should be set for two full days. What the benchmark study at the Swedish bank shows, further supported by findings in various research studies presented in the theory chapter, is that the PI planning session is the most essential part of the SAFe framework, which really tends to make a difference. As external Interviewee N said:

"We do the same thing as teams are doing on their team planning, just do it for all teams and all stakeholders for two days. And that is when it works, it is really magic." - Interviewee N

By having these meetings there will be a consensus about what is most important for the end customers and thereby for the business. There needs to be an agreement about what should be done in the next program increment. What the PI planning does is that it forces this agreement to

be reached, because otherwise the train will not be shippable. By having the meetings face-to-face it will be much easier to synchronize deliveries with regards to the different teams inherent in the release trains. Dependencies will be identified and the importance of different things will easier be understood and agreed upon. By involving stakeholders from different departments, such as operations, development, system owners, application users and business units, the end-to-end-flow will be better understood and synchronized.

The end-to-end value chain is something that several interviewees pointed out as an area which needs greater focus and which is central in agile development. By looking from the perspective of end customers, recognizing what business features need to be built and with what quality they need to be built with, the infrastructure requirements can be understood. Thereby including the infrastructure so-called enabler work in the release trains. Continuously building and rolling out just enough of the infrastructure to give the right support for being able to build what we want for the business, fast enough.

The idea is that not only small, but also major necessary infrastructure transformation work will be identified in this way. This work can be seen to be corresponding to today's projects. These large programs, or epics, will be carried out throughout multiple release trains and will likely cross different release trains. By having the continuous PI meetings, there will be better clarity about prioritization of this work. This will help in the allocation of line resources and when it is the best time to book service windows for making the changes at different places, such as remediation work or migrations.

As understood by above paragraphs, the DevOps concept is emphasized within the SAFe framework. Central here, is automation and testing which was pointed out by interviewees as an area which needs to be addressed. The framework encourages regular integration testing at system level and larger solution level. The continuous testing will help to make sure that the right operative capacity is met to support the running of new software being developed.

Testing should be automated wherever possible. This is the agile way, to make as small changes as possible, as often as there is a need for it. Thereby, preventing technical debt. Demo testing environments and new extensions to them will need to be set up by infrastructure teams.

Within the program increment and within the teams, the infrastructure work may advantageously be executed at team level in the way which is analyzed and described above in previous analysis subchapters, in a 'Scrumban" way. In line with what the framework suggests, there may also be a need for frequent meetings within the program increments between different teams, including infrastructure project teams, to follow up progress towards milestones, identify dependencies, coordinate between the teams and identify blocking issues.
It was also mentioned in an interview with an external interviewee how there can be benefits by having a representative strategic group consisting of members from different units with an organizational strategic overview, who will need to re-prioritize teams' backlogs between each sprint. At the program and organizational level, this can be seen to be addressed by the SAFe framework by the re-prioritization which occurs between each program increment among business stakeholders. The idea with the SAFe framework is namely that much of the organizational strategic

responsibility is pushed down in the organization to the business stakeholders who agree on what is best for the business in the PI meetings. They will thereby be directly responsible for implementing the strategy of the organization. By having these PI meetings, it will then likely be easier to have the infrastructure transformation projects represented by business interests, and have a role assigned for the projects which have clear insight into business needs.

Furthermore, as stated in the benchmark study interview, key roles for the SAFe framework will be to have system architects on the program level and enterprise architect on the portfolio level to envision the architectural vision. Moreover, which can be seen as corresponding to the enterprise architect, the empirical findings suggest that it would be good to have a solution manager who has a close ongoing dialogue with business unit stakeholders in order to take in architectural solutions from the client perspective. This is something which can happen continuously throughout the program increments and facilitate for the PI meetings, where the architects can communicate to the participating stakeholders about the enabler work which needs to happen.

The implementation of the SAFe framework will however not come without challenges, if looking at the benchmark study with The Bank. The biggest challenge, which will certainly be a big challenge at Telia as well, is to make the SAFe organization work with the current organization.

The main idea with the SAFe organization is to not have projects, only have continuous work being performed by change teams, which comes in from the prioritized backlog. At The Bank, this is a real struggle, considering that there are parts of the organization that still work in projects. This creates a dilemma with regards to government structure. As long as you have both of these structures, it will be challenging to integrate two government structures into one. There will be different organizational structures requesting and requiring work to be performed from the same resources, which will create confusion. An internal interviewee also stressed the importance of working continuously with implementation, with teams that have been involved in the implementation of the new platform from the beginning. If doing this more, the need for larger infrastructure transformation projects will likely be reduced after some time.

What is recognized by the benchmark study, is that the technical setup is the easy part. It is complicated, but not complex. This is furthermore confirmed among the internal interviewees at Telia. It is rather how to understand leadership when moving up in the organization from team level that includes the biggest challenges which The Bank is facing right now. The study identifies that this will be a really challenging area for Telia as well, considering the centralized government structure. The idea with the SAFe framework is that the organization should be self-organized. This should be done by pushing down organizational strategic solution responsibility down in the organization, making it more decentralized. The organizational solutions will be continuously developed among stakeholders' interactions throughout the program increments. As the study identifies both by external interviews and internal interviews, it can be hard on team level to find product owners who actually represent the business. At the program level, this difficulty becomes even harder, when program management will be responsible for developing solutions for the organization and actually implementing strategy for the organization directly. It is a change of mindset which makes the transformation very difficult. Also, as recognized in the study, the need

for certain roles may be questioned. This challenges people's identities and positions of power, which will most likely trigger some resistance for the transformation.

When analyzing the project structure at Telia with SAFe theory, the idea will be to try to shift project managers into becoming epic owners instead. Thereby creating budget awareness of these largest sets of requirements, and integrating them into the SAFe way of working. In this way, the enabler epics can be constantly looked out for how they are being implemented on the trains. It may become a challenge to see how these epics will attach to different release trains, and thereby plan properly for them in the PI meetings.

6 Conclusions

In this chapter, the research questions are firstly answered. This is followed by a presentation of the proposed model for agile execution of IT infrastructure deliveries, based on the findings. Next, a discussion of managerial- and sustainability implications are followed. Then, relation to previous literature, practical- as well as academic contributions are concluded. Finally, the limitations of the study are stated and areas of future research proposed.

6.1 Summary of Findings

The purpose of the study was to investigate how IT infrastructure transformation projects at telcos can be executed in an agile way at telcos. In this section, the research questions which were formulated to address the purpose, are answered.

Research Question 1

What are the challenges telcos are facing in the execution of IT infrastructure transformation projects?

There are a number of challenges which the IT infrastructure transformation projects are facing in the execution phase at telcos. First of all, the transformation projects tend to be extensive due to lack of continuous exchange of infrastructure components in the IT environments. Thereby, building up a lot of technical debt which is handled reactivity and which is often part of projects' scope.

Seen from the big picture, the main challenge identified comes down to alignment with the rest of the business. The projects have many touchpoints with other parts of the business and furthermore, the value of the deliveries is ultimately defined by the needs of the business, which is operating in an ever-changing environment.

Elements of the challenge include stakeholder communication in order to deliver the right solutions according to the business needs and the operational requirements. Also, scheduling for change windows and allocation of crucial business resources in order to proceed with transformation, may be stalled due to conflicting interests from other parts of the business. Execution may further be stalled due to badly updated information about system configurations and contact persons, which makes it time-consuming to find out such information, especially if the knowledge has been lost.

The greatest part of the challenge, however, seems to be organizational readiness. A silo structured organization makes it hard to align delivery processes. Furthermore, people's understanding and mindsets of agile makes it hard to adopt agile ways of working, considering that agile needs a unified effort.

Lastly, the success of projects is dependent on good workflow management, communication and collaboration among project members, due to their complex nature and continuous discoveries of new things, causing needs for re-planning.

Research Question 2

How can agile ways of working help to cope with the challenges and facilitate for execution of IT infrastructure projects at telcos?

The study concludes that a way of working influenced by Scrum and Kanban at team level in the infrastructure transformation projects help in terms of continuously improving processes, fostering team communication, team collaboration, planning effectively and managing workflow. This in turn helps to foster a more agile execution, where obstacles are identified proactively, best solutions better generated and the consequences of needs for re-doing are smaller. The study furthermore suggests that stronger dedication to these agile practices, regular retrospectives in particular, will contribute to improved results, especially in the long-term.

The study identifies that a technical coordinator who facilitates teamwork is a key role which is sometimes missing. The study suggests that teams' performances are enhanced by full-time dedicated team members and if the teams are stable over a long time. Moreover, if the teams are cross-functional and if team members are involved in process improvements and decisions on communication practices.

Furthermore, the sharing of lessons learned between projects may be facilitated by introducing a searchable platform where knowledge, best practices and the people to contact is easily found. Moreover, the study identifies that more internal marketing towards stakeholders such as system owners may help to create initiatives and understanding of value contribution of life cycle management and updated information and thereby facilitate for more agile transformation.

Moreover, close collaboration with IT Ops helps in order to manage successful handovers where the operative requirements for new environments are met.

The study suggests increasing focus on continuous maintenance of new platforms implemented by the projects, to prevent technical debt, live up to changing business requirements and gradually reduce the need for large-scope projects. Same people who have been involved in implementation may have continuous responsibility. To make this practically possible, the study identifies that the time has come to seriously start automating and improving test procedures. Testing needs to be integrated with other deliveries, test non-functional requirements and be much more frequent.

The study concludes that the benefits of applying agile practices at infrastructure team level, is to a large extent constrained by organizational structure and alignment with the rest of the business. The study concludes that a key for more agile execution of infrastructure transformation is to align deliveries closer with the rest of the business. This requires organizational initiatives.

The SAFe framework is identified as a suitable framework addressing many of the challenges inherent with regards to business alignment. By applying DevOps, measuring results and by bringing together stakeholders at a regular basis, communicating, identifying and planning for the implementation of required infrastructural transformation work, alignment and understanding is fostered, as well as the ability to respond to change. This will help to cope with the challenges by

fostering a continuously improved end-to-end delivery process, facilitating prioritization issues and fostering a just-in-time-and-just-enough value based implementation in an ever-changing environment.

Key roles identified in this framework with regards to infrastructure work are the architects at program level and enterprise level. Furthermore, the framework may utilize for a role or function within the projects that represent the business side.

6.2 The Agile Model

In this section, the proposed agile model created for IT infrastructure transformation projects, mainly customized for the commissioner Telia Company, is presented. The model includes guidelines and recommendations based on the analysis of the empirical results as well as agile literature which are explained both visually and in text.

The purpose of this master's thesis has been to investigate how IT infrastructure transformation projects can be executed in an agile way at telcos. Further, the commissioner Telia Company requested an agile model for this, resulting in an expanded purpose for the study. The challenges and potential improvements in the execution phase of these types of projects were examined and some specific areas where studied more in detail. Thereafter, the discovered challenges as well as areas of improvements were analyzed and reinforced with agile theory. The outcome of this is realized as an agile model. A timeline of the execution phase of the projects including areas with proposed recommendations, visualized as different symbols, can be seen in Figure 9. The specific areas the model looks into are namely; Team, Team Communication & Administration, Life Cycle Management, Customer Engagement, Life Cycle Management, Continuous Improvement, Testing, Retrospective, Business Alignment, Lessons Learned, Project Ending and Continuous Work. The agile model, including symbols of each area along with given actions, motivations and further comments can be read in the following pages.

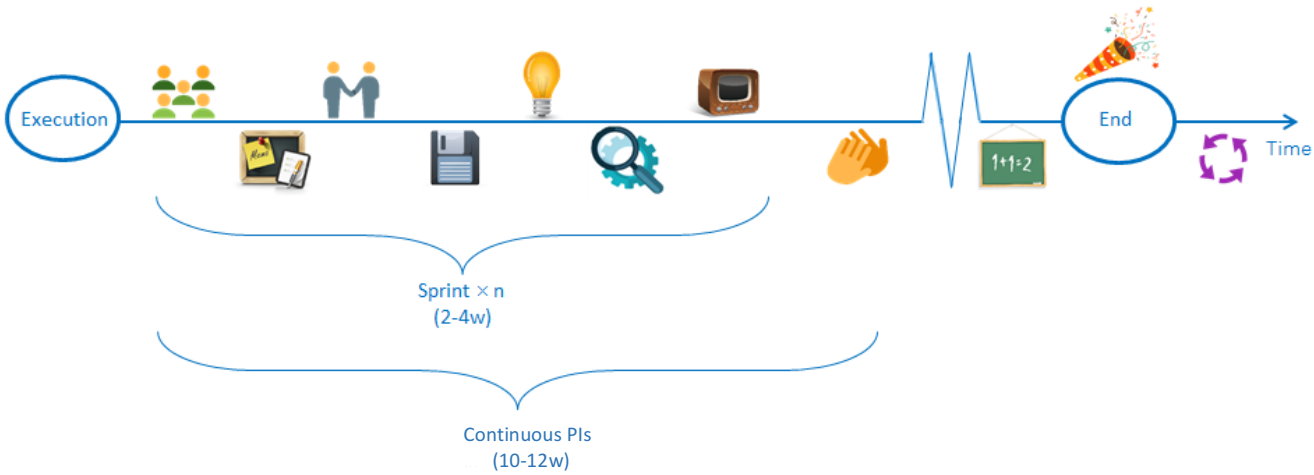

Figure 9. A timeline with activities for the agile execution.

The Agile Modell

Area	Action	Why	Note
 **Team**	-Full-time dedicated and physically co-located project members to largest extent possible -Resource lending flexibility towards other projects -Stable teams over long time-periods -Cross-functional teams to largest extent possible -Key role: Technical coordinator, Business representative	Collaborative, effective, solution driven and synchronized teams foster agile deliveries	
 **Team Communication & Administration**			
Meetings and Continuous Planning	-Meeting structure decided by project team (types of meetings, frequency, participants, who talks, etc.) -Few, short, effective. Preferably face-to-face Leave room for people to discuss and solve issues after -Daily short morning meetings within technical teams (what did I do, what will I do, and what is getting in my way?) -Weekly follow up and planning meetings (May include technical representatives from different sub-teams involved in delivery) -Monthly sprint review and sprint planning -Set areas of responsibilities and make an action plan	Break down work, discover hidden obstacles, allow for small adjustments, endorse responsibility, find best solutions, foster collaboration etc.	Guidelines according to what tends to foste good communication
Visualization	-Use of boards, diagrams and burndown charts	Track progress, manage workflow, discover dependencies, synchronize deliveries, facilitate quick understanding, etc.	More support for visualizing tools may needed
Project Related Documents	-Question and discuss what value the documentation brings -Minimize direct emailing to project resources if not necessary	Reduce time consuming documentation and processing of it	

Area	Action	Why	Note
 **Customer Engagement**			
IT Operations	-Consistent involvement, may be done by backfilling. Inform and invite to meetings	Manage requirements	
Business Clients	-Close dialogue. Inform and invite to meetings	Manage requirements and expectations	
System Owners, Business Unit Managers, etc.	-Internal marketing (web channel, workshops, meetings) and informing	Foster understanding of value contribution	
 **Life Cycle Management**	-Internal marketing (web channel, workshops, meetings). -Certificates stating that information has been overlooked and is correct. -Make LCM and updating of systems information a more prioritized activity from higher management -Connect systems with similar requirements to same platforms/servers	Enable more agile transformation executions and reduce technical debt	Much a prioritization and budgeting question
 **Continuous Improvement**	-Process improvement idea generation from technical resources (Not necessarily project related) -Individual feedback every 6 months	Stimulate motivation and utilize valuable insights from ‘’the guys working with it’’	Requires responsil function to drive tl idea proposal and provide feedback a realization potenti
 **Testing**	-Consistent testing, including non-functional requirements of system functionalities in production environments. -Automate testing wherever possible	Reduce technical debt and improve estimation of enabler and business features	Reduce technical d and improve estim of enabler and bus features

Area	Action	Why	Note
 **Retrospective**	-Monthly team retrospectives (face-to-face) followed by responsibilities to set improvement agreement in motion	Continuous project execution improvements (particularly long-term)	
 **Business Alignment**			
Roles	-Key roles: Enterprise Architect, System Architect	Responsible for envisioning the architectural runway and communicate it at PI meetings. Close dialogue with business stakeholders	
PI Meetings	-Every 10-12 weeks -All stakeholders (e.g. IT Ops, IT Infra, Developers, Business Unit Managers, System Owners etc.) -Agile Release Trains, consisting of team-of-agile-teams, plan their integrated PI deliveries. -Necessary enabler work, including enabler epics' work is communicated by enterprise architect/system architect, as well as non-functional requirements	Foster end-to-end delivery processes and lean, emerging architecture to support the business with fast-enough building of business oriented services in demand. Foster understanding and smooth execution of transformation projects (enabler epics) as well as defining new enablers to address restrictions from current non-functional requirements. Lastly, facilitates resource and activity prioritization issues	
Measuring	-Measuring KPIs such as the time it takes to roll out new business oriented services	Understanding results in order to streamline delivery processes	

Area	Action	Why	Note
 **Lesson Learned**	-After project: Lesson Learned meetings. Lessons learned documented by a contact person in a searchable way. -Setting up workshops	Easily utilize valuable and practical knowledge from previous projects	Need for initiative to structure a searchable platform
 **Project Ending**	-Celebrate finished project together with all project stakeholders	Receive credit for accomplishments and endorse team spirit	
 **Continouos Work**	-Handover responsibility for continous implementation work within new environment according to SAFe way of working, preferably to people who have been involved in the project -Automated testing should facilitate needed effort	To prevent building up of technical debts and support new business and software requirements	

6.3 Managerial Implications

Discussion of model

The study investigated the way infrastructure transformation projects have been executed at Telia Company. The intention was to see how agile practices, based on literature as well as experiences and insights from internal and external interviewees, can help to execute projects in an agile way. The findings were collected and analyzed in order to lay out a model which resembles what the study identifies as best methods.

At team level, the laid-out practices may not raise eyebrows in terms of new ways of executing in an agile way. However, the presence of these practices seems to have been varied and some non-existent within the projects. What the study shows is that, when applied, they tend to generate improved results. Therefore, we see the value of collecting these insights from people and compiling them into the model.

Even though there may be insights about the benefits of some suggestions, some recommendations may not always be the easiest to realize due to prevailing conditions, such as full-time dedicated project resources, engagement from stakeholders and establishing cross-functional teams. However, the study has still acknowledged the importance of these factors and laid out some recommendations which help to foster the realization of them.

The model furthermore contains a number of agile enabler initiatives which need efforts from people outside of the typical project frame. This includes things such as investing in and structuring integrated, automated testing approaches, structuring a searchable platform for lessons learned between projects and connecting systems with similar requirements to the same platforms. Moreover, initiatives for life cycle management and documentation of system configurations, responsible function for realizing process improvement ideas and realization of SAFe. Thus, these are recommendations which are up for consideration just like the other suggestions, but which need further efforts for realization.

The study identifies that the use of agile practices at team level may only lead to moderate results, since the surrounding organizational context constraints the possibility of agile execution. Alignment with the rest of the business in terms of resource allocation, scheduling, requirement pictures, prioritization, common mindsets and fostering cross-functional end-to-end value streams are identified as the biggest challenges to become truly agile.

What the study identifies to address this and as a way forward in order to achieve a more agile infrastructure delivery is the adoption of the SAFe framework. As the framework emphasizes an approach of continuous delivery of emerging architecture just-in-time-and-just-enough to enable the fast-enough building of business oriented services in demand, the framework suggests having fixed system teams which are constantly pulling enabler items from the prioritized backlog, thereby working in a non-project alike way. This way of working appears to be non-existent at Telia Company, and it is therefore time to shift towards this way of working, which is the agile way. The close cooperation with other development teams, stakeholders and departments, helping to set up

synchronized delivery solutions at scale, will naturally foster end-to-end delivery processes whose results, such as cycle times, can be easier measured and understood.

Furthermore, the framework also recognizes that enabler epics, corresponding to today's large infrastructure transformation projects, need to happen. Also, that they need to be widely implemented across the organization in order to provide with the right environments which can support system quality demands on security, reliability, performance, maintainability, scalability and usability. Considering that the framework puts strong emphasis on communicating and identifying required enabler work with stakeholders as well as planning for smooth implementation of them, the framework will naturally foster more agile execution of these infrastructure transformation projects. Looking further, at PI meetings, where management and different stakeholders meet directly at regular intervals, with a more decentralized government approach, enabler epics and business epics can be easier discussed, understood, agreed and prioritized at portfolio level. Thus, also facilitating the role of business representation within the transformation projects. This government approach may even allow for more frequent budget re-allocation of them, tentatively every second PI meeting (about twice a year).

Going forward

Just as the study concludes, the literature study suggests that the key for agile in large organizations lay not in the agile practices per se, but with the alignment between different business functions. This, along with above argumentation and successful adoptions in terms of improved results and business alignment at other organizations, shown by literature study and benchmark study, is reasons why the adoption of the SAFe framework is recommended. Literature study and benchmark also suggests that investing in PI meetings really tend to be productive and pay off, even in the cases of doubtfulness. However, as we can see at the benchmark organization, the implementation will certainly not come without challenges. Challenges involve a change of mindset due to decentralized strategic responsibility and how to integrate the current organization and its government structure with the SAFe organization.

If implementing the SAFe structure, the way the enabler epic teams work in their sprint routines may shift a bit from the proposed model considering that the SAFe framework encourages agile teams to work in 2-week sprints ending with testing, where the last sprint focuses on planning and innovation and larger solution testing. With regards to this, infrastructure teams may play an important role in setting up the right testing conditions.

Considering that the study does not explore in detail how an adoption of the SAFe framework may work in practice, but rather identifies it as a suitable framework in order to address IT infrastructure transformation challenges at Telia Company, we propose that future work should look at how the set up can look like in practice. This would include looking at how the meeting structure of the PI meeting should look like, what stakeholders should participate and how the agile release trains should be organized. Above all, looking at how enabler epics crossing multiple agile release trains are effectively planned for and synchronized between different agile release trains during the PI planning sessions. Furthermore, at scaled level look at how cross-team communication practices (in literature, shown to be challenging) and testing procedures can be organized throughout the

agile release trains in order to foster a continuous implementation of the required infrastructure components. Thus, keeping up with an ever-changing environment.

As has been shown to be success factors, we propose to consult professional SAFe experts in order to look at this closer, set up the rest of the necessary organization, provide training and get started with the PI planning and program increments.

6.4 Sustainability Implications

Telcos' services will play an even more important role tomorrow due to the shift towards a connected society. Thus, they have a huge possibility and responsibility to shape the society into a socially, economically and environmentally sustainable society. Telia Company is a large telco who recognizes their position in this context. They have a strong, outspoken ambition to lead the development and play a central role in tomorrow's connected, smart, sustainable society. In order to reduce environmentally unsustainable car traffic, Telia can help to create smart logistics of public transport, making this option more attractive. Furthermore, Telia can help to enable the infrastructure for smart electricity supply. Through a socially sustainable perspective, Telia can help to enable efficient home care of the elderly in a population whose retirement share and age levels are growing. Moreover, to create a safe and secure digitalized experience for youths who are interacting over the web and social media. Lastly, by building smart societal infrastructure together with other actors, economic sustainability is fostered for different actors in society, for the welfare system and for the nation's global competitive ability. These are just some of many examples how Telia can contribute to a sustainable society. How does this relate to the study then? Considering that agile transformation of IT infrastructure enables a faster development towards realizing these visions, the contribution of the study supports a sustainable agenda.

6.5 Relating the findings to previous research

Previous studies suggest that large organizations' abilities for being agile is dependent on their abilities to scale agile to all business units and functions and be aligned across the organization. It has been lifted that the greatest challenges do not lie in the agile practices per se, but in their relations with existing organizational processes. The results of this study support this view, as it identifies that it can be hard to align deliveries with business needs in a silo structured organization. Furthermore, the executions of the transformation projects are shown to be restricted by surrounding organizational processes.

To achieve agility throughout the entire value chain by collaboration with IT and business in the context of IT transformation, has been lifted in the literature to see many challenges. The study supports this as it is shown that the business representation in the transformation projects is often vague. The gap is often big and the understanding of the projects low, as they typically do not generate any new business directly.

Previous research also shows that it can be hard to develop, deliver and maintain IT platforms due to volatile operational processes, distributing operational resources in projects and working with non-project based work. The results of this study acknowledge this. In an incident action-based

organization it tends to be hard to involve operational resources in projects and to prioritize life cycle management.

Moreover, previous research suggests that it can be hard to allocate cross-functional teams with diverse competence from different areas of the organization, allocating them full-time as well as gathering them to work at the same location. The results of this study support these observations. A silo-based functional organization, a constraint resource pool and a geographically spread out organization, makes it hard.

Research also suggests that it is crucial to understand the reason why one is using agile in order to implement it. The results of the study show that people have different views on agile, but also different perceptions and understanding about how it can be adopted and what benefits it can bring, resulting in that not much happens. In this way, the study supports the view that it makes agile implementation hard.

6.6 Contribution to knowledge

This study contributes to practical knowledge to large IT organizations with legacy infrastructure who face similar challenges as Telia Company with regards to IT infrastructure transformation. The results contribute with insights about agile ways of working within these kinds of projects and what the expected results may be in relation to prevailing organizational circumstances. It furthermore contributes with understanding about how a scaling agile initiative may be suitable in order to enable more agile infrastructure delivery.

Academically, the study contributes with empirical findings and analysis within an area which is lacking in the published research domain. Namely, agile execution of IT infrastructure transformation at large, traditional companies. The study identifies challenges as well as proposes solutions, thereby encouraging a future discussion in the research domain. From the IT infrastructure perspective, it furthermore supports findings in previous research regarding agile obstacles and challenges.

6.7 Limitations

The study was limited to 20 weeks, constraining the scope and the depth of the study as well as the possibility to further investigate areas of particular interest discovered late in the process. Furthermore, the study was limited with regards to the applicable use from the scarce amount of research published within the area of investigation, namely agile execution of IT infrastructure transformation projects. Moreover, the study had limited access to external interviews and benchmarking. Many people and companies, Swedish as well as foreign, were contacted in order to gain outside perspectives and learn from other organizational examples of IT infrastructure transformation. However, lack of response, busy agendas and confidentiality regulations were reasons why contact attempts failed.

6.8 Future Studies

The study identifies areas of research which are encouraged for future studies. First of all, further case studies of IT infrastructure transformation initiatives are encouraged. This is relevant considering the large amount of organizations who need to transform their IT landscapes to keep up with the competition. Learned keys for success, best practices and pitfalls are interesting in this sense. Furthermore, the literature is lacking in empirical studies of adoption cases where agile has been scaled. Empirical evidence on results, biggest challenges and how they were handled are encouraged in this context. Another interesting area of research which raised attention during the course of the study and which was noted as missing in the research, is how resource constraints within an organization affect the organization. This may bring forward interesting research studies about how to best handle this problem. An interesting dimension of this problem, is further in the situation where you have multiple government structures within the organization, where different setups of the organization are competing for the same resources. For example, if there is one part of the organization practicing SAFe and other parts of the organization that are practicing traditional project governance.

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