The London School of Economics and Political Science

The role of digital infrastructures in performances of organizational agility

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

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Abstract

Organizational agility has received much attention from practitioners and researchers in Information Systems. Existing research on agility, however, often conceptualizes information systems in a traditional way, while not reflecting sufficiently on how, as a consequence of digitalization, they are turning into open systems defined by characteristics like modularity and generativity. The concept of digital infrastructures captures this shift and stresses the evolving, socio-technical nature of such systems. This thesis sees IT in large companies as digital infrastructures and organizational agility as a performance within them. In order to explain how such infrastructures can support performances of agility, a focus on the interactions between IT, information and the people using and designing them is proposed. A case study was conducted within Telco, a large telecommunications firm in the United Kingdom. It presents three projects employees regarded as agile. A critical realist ontology is applied in order to identify generative mechanisms for agility. The thesis develops a theory of agility as a performance within digital infrastructures. This contains the central generative mechanism of *agilization* – making an organization more agile by cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility. This is supported by the related mechanisms of *informatization* and *infrastructuralization*. Moreover, the concept of *bounded agility* illustrates how people in large organizations do not strive for agility unreservedly, instead aiming for agility in well-defined areas that does not put the business at risk. This theory of agility and the concept of bounded agility constitute the main theoretical contributions of this thesis. It also contributes clear definitions of the terms ‘information’ and ‘data’ and aligns them to the ontology of critical realism. Finally, the proposed mechanisms contribute to an emerging middle range theory of organizational agility that will be useful for practitioners.

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1 Introduction

1.1 Motivation and object of research

Organizational agility is commonly defined as the ability of firms to sense environmental change and respond readily (Overby et al. 2006). There is broad interest in the topic among Information Systems researchers, as evidenced by the recent literature reviews by Singh et al. (2013) and Salmela et al. (2015). This interest is shared by practitioners: Throughout the work on this thesis, business agility has been consistently listed as a top 3 concern of international senior IT executives (Luftman et al. 2012; Luftman et al. 2013; Luftman et al. 2015). This section outlines the motivation to research organizational agility, and why this particular approach was chosen. This thesis combines two distinct areas of Information Systems research: Organizational agility, which is characterized by mainly rational, empiricist research, and the study of digital infrastructures, which originated from the tradition of social science based Information Systems research.

1.1.1 Information Systems strategizing

Information Systems research on organizational agility is here seen as a subset of the broader area of Information Systems strategizing, which looks at the question of how information systems can support an organization's success in general. Galliers (2011) points out the "problematic nature of key tenets of much of the mainstream Information Systems strategy literature" (p. 329) like alignment and competitive advantage. He points to the problem of "aligning dynamic information needs with a relatively static technology (…) [and] harnessing an increasingly commoditized technology to provide competitive advantage" (ibid).

Currently, the field has to conceptualize the changing role of IT and its relation to the organization. In much existing research, IT is seen as a separate, contained entity that the business can use to achieve its purposes. This is reflected in the view of IT as a capability (e.g. Chen et al. (2013) following Bharadwaj (2000)). This ignores more recent, broader views on the role of IT, e.g. the concept of digital infrastructures (Tilson et al. 2010). As this thesis will illustrate, these have been enabled by digitali-

zation, which has led to more modular and generative information systems in organizations.

1.1.2 Organizational agility research

Existing Information Systems literature on organizational agility is criticised for a lack of variety in a recent literature review:

> It is difficult to avoid the impression that there is a lot of similarity in central arguments regarding antecedents and value of IS agility in different domains. It is also easy to share concerns raised by Conboy [2009] about lack of clarity, theoretical-glue and conceptual parsimony, not only in the agile IS development research stream, but across all research streams covered in this review. (Salmela et al. 2015, p.12)

Indeed, much research on organizational agility takes a positivist stance and is based on quantitative data. There is some research based on qualitative data, which is more focused on developing a thorough understanding of the processes at play rather than measuring subjective opinions in surveys. In general, however, existing research in this area tends to see information systems as static, monolithic systems and often sees IT simply as a tool to achieve business goals. What is lacking from such research is a more nuanced view of the role of IT in organizational success that takes into account how it shapes organizational settings by interacting with the people in an organization. Thus an important part of the research problem is the role of IT in organizations and the way it is conceptualized. Any step towards understanding this problem would also contribute to a better understanding of the wider area of Information Systems strategizing.

1.1.3 Digital infrastructures

This thesis argues that the field of organizational agility research within Information Systems would benefit from a research approach based on the concept of digital infrastructures, defined as open, evolving sociotechnical systems. This concept reflects on the consequences of digitalization and allows a focus on the evolution of systems over time. It is well established in recent Information Systems research, but has not yet been used much in areas usually researched by management-focussed researchers, including organizational agility – despite Tilson et al.'s (2010) broad call for research that aims at a “better understanding of the ways in which infrastructural

change shapes IT governance, IS development, and promotes new effects across all levels of analysis" (p. 757 f.).

To distinguish digital infrastructures from IT and information systems, this thesis adopts these terms as follows:

- IT – information technology, focused on technology alone.
- Information systems (IS) – here defined as "information and data handling activities in human organizations" following Avgerou & Cornford (1993, p.1). Information systems are seen as sociotechnical systems, with a focus on their use in organizations (performances). They are also seen as monolithic and restricted to one organization.[1]
- Digital infrastructures (DI) – heterogeneous (e.g. consisting of variety of different information systems), evolving sociotechnical systems.

1.1.4 Practical problems

Achieving a better understanding of organizational agility would also address significant problems of practitioners. As companies struggle with ever increasing competitive pressure (Highsmith 2002; D'Aveni 1994), organizational agility – commonly defined as the ability of firms to sense environmental change and respond readily (Overby et al. 2006) – is seen as a potential competitive advantage by many (Sharifi & Zhang 2001). In recent years, there has been increased interest in the topic both from practitioners and academics. Such views are founded upon the belief that if companies do not achieve agility, they will be at a disadvantage against agile competitors, though they remain unclear as to how to achieve agility.

Agility is broadly seen as an important factor for firm success (e.g. Huang et al. 2014). Sambamurthy et al. (2003, p.238) point out that "[a]s contemporary firms face intense rivalry, globalization, and time-to-market pressures, agility (…) is considered to be an imperative for business success". More recently, Roberts & Grover (2012, p.232) find that "[i]ndustries once considered relatively stable have evolved into fiercely competitive environments in which long-established giants are being threatened by agile start-up firms scattered across the globe (…) As a result, firms must sense and respond quickly to opportunities if they wish to build a competitive

[1] The research field of Information Systems is spelled with capital letters in this thesis in order to distinguish it from information systems as described here.

advantage". Sambamurthy et al. (2003, p.238) identify "[t]he convergence of computing, communications, and content technologies" as a driver for this development. There is a broad consensus that "[t]he advent of new information and communication technologies presents unique opportunities for firms to enhance their customer agility" (Roberts & Grover 2012, p.232). Also, the world has become more globalized (Chakravarty et al. 2013), adding further competitive pressure. All these factors mean that the speed of change is increasing, leaving companies with the impression that they have to be able to react and adapt quickly. There appears to be a common perception among practitioners that that if companies do not solve the problem of how to achieve agility, they will be at a disadvantage against their competitors.

A look at the origin of the concept illustrates why it has become so relevant. The idea can be traced back to the concept of lean manufacturing in Japan's industry in the 1990s (Baskerville et al. 2005), which was seen as superior by American and European managers. The concept of agility is broadly used in software development, where the agile manifesto (agilemanifesto.org 2001) reflected the desire of a group of developers for a new workflow based less on formalized procedures and more on communication and flexibility. Interestingly, speed itself is not a goal of the manifesto. The term was soon adapted in the management literature as well (Goldman et al. 1994). As discussed, many mangers felt their organizations needed to be agile in order to be able to compete in the market place. They were facing some similar issues as software developers in that they were slowed down by processes and rules that had accumulated over time and were looking for a way to achieve similar results with less bureaucratic effort.

The main practical problem this thesis addresses is the question of how large companies can achieve agility. This is an issue that many companies care about, as evidenced by practitioner publications like Grantham et al. (2007), Green (2011) or Le Clair (2013). Thus, the main practical contribution to be expected from this thesis is a better understanding of agility, the elements supporting it, and the role IT plays in the process.

1.2 Research Project

1.2.1 Theoretical Framework and Research Questions

This thesis applies the concept of digital infrastructures to the field of organizational agility research, seen as a subset of Information Systems strategy research. It argues that, due to digitalization, the focus of Information Systems research in organizations should shift from static information systems to dynamic, sociotechnical digital infrastructures. The argument here is that because of digitalization, research needs to look at Information Systems strategy in a different way that takes digital infrastructures and their generativity into account. Specifically, it is argued that the field of organizational agility would benefit from such a research approach. Following Zheng et al. (2011), agility will be conceptualized as a performance rather than a static quality. The research question is: How can digital infrastructures support performances of agility in organizations?

1.2.2 Case Study

To answer the research question, a case study with a telecommunications firm (here called Telco) has been conducted. Telco serves as a typical case as it represents many large organizations that have grown historically and are now facing the issue of having to compete against smaller, younger competitors, who are often seen being more agile, i.e. better able to respond to changes in the market as they are less restrained by the bureaucracy of a large company. Thus, senior management in Telco has expressed a desire be more agile. In Roberts & Grover's terms, Telco can be seen as one of the 'long-established giants' that are 'being threatened by agile start-up firms'.

The case study finds that employees see Telco largely as non-agile, but nevertheless acknowledge the existence of some areas in which it has been able to develop new digital infrastructures in order to successfully make changes more quickly in response to market needs. Three of these are researched in detail in this thesis:

- Analytics, the use of existing transactional data for real time business decisions
- OfferMaker, a tool that enables employees without programming skills to create new offers for the web shop

- SalesTool, a new interface for an existing tool that better supports the workflow of sales agents by presenting the information they need when they need it.

The analysis follows the critical realist principle of retroduction, i.e. proposing and testing various generative mechanisms and comparing them for their explanatory potential. It employs the framework for conducting explanatory research in critical realism by Danermark et al. (2002) as it offers the most specific guidelines on how to identify mechanisms. This leads to an explanatory framework consisting of three main generative mechanisms that support these successful projects of agility:

- *Agilization*: Cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility
- *Informatization*: Converting data into information and managing and sharing information within a digital infrastructure. Informatization itself is supported by the mechanisms of *information growing*, *information cooking* and *information serving*, which illustrate some successful interactions with information.
- *Infrastructuralization*: Interpreting the information systems in organizations as digital infrastructures

These mechanisms are described with a focus on their interaction with the digital infrastructures in Telco. The analysis also shows that rather than strive for agility unreservedly, employees of Telco aim for *bounded agility*, defined as striving for agility only within the limits set by the digital infrastructures or the organization, as they have to consider constraints imposed by organizational or legal concerns as well as by the digital infrastructure itself. Consequently, a dual nature of digital infrastructures as both enabling and constraining organizational agility is developed. Examples for this are the bureaucratic processes that are part of running a large organization, concerns about protecting customer data and the limited flexibility of organizational information systems that have grown over decades.

1.2.3 Contributions

The main theoretical contribution of this thesis will be to combine the two fields of organizational agility research and research on digital infrastructures into a theory of agility as a performance within digital infrastructures, thus helping to improve the

conceptualization of agility. This would also contribute to a better understanding of the wider area of Information Systems strategizing. The field is currently trying to conceptualize the changes brought by new, modular and generative technologies (Tilson et al. 2010; Yoo et al. 2010; Fichman et al. 2014) and there is an on-going debate about how to develop a stronger profile for the field of Information Systems based on original theories (Grover & Lyytinen 2015). The approach taken here can provide useful insight to these debates. This thesis contributes to the literature on agility by pointing to the limits of agility in the context of a large company. Furthermore, the identified mechanisms may turn out useful as models for future research and contribute to an emerging middle range theory of organizational agility. As pointed out above, the main practical contribution is a better understanding of agility, the elements supporting it, and the role IT plays in the process. In particular, it is hoped that the mechanisms defined should help practitioners in the planning and management of digital infrastructures.

1.3 Outline of the thesis

This thesis is structured as follows: The literature review (Chapter 2) places the thesis in the field of Information Systems strategizing and discusses current debates in the field. It then looks at the sub-field of research on organizational agility in more detail and discusses prior research. Finally, it introduces and discusses the new theme of digital infrastructure research, pointing out how research on organizational agility may benefit from this concept. This leads to the research question, "how can digital infrastructures support agility in organizations?".

The conceptual framework (Chapter 3) defines a set of concepts and relationships that will be used as the basis for the case study. It is based on digital infrastructures, seen to consist of the installed base of IT, the people using and designing them, and information. They are seen as simultaneously enabling and constraining agility. Within this framework, the focus is on performances of responding to changes in the outside world.

The research design chapter (4) discusses how to answer the research question. It describes the design for a case study and reflects on the methods of data collection and data analysis as well as the generalization of findings. It argues for a critical realist ontology, combined with an interpretivist epistemology. This leads to an

iterative process of data analysis, based on the principle of retroduction. The analysis aims at defining generative mechanisms of agility.

Chapter 5 introduces the site of the case study, Telco, and presents the findings from the case study. It finds that employees did not see the company as agile, but pointed out some successful projects of agility within the company. Three of these are presented in detail.

The analysis (Chapter 6) applies the conceptual framework to these findings in order to answer the research questions. It uses the critical realist principle of retroduction to identify generative mechanisms supporting agility. Danermark et al.'s (2002) framework is applied and extended by the concept of the hermeneutic circle (Krippendorff 2004) to illustrate the iterative character of the analysis. The chapter discusses limitations on agility within Telco and identifies an explanatory framework, consisting of generative mechanisms explaining how digital infrastructures support agility in this case.

The discussion (Chapter 7) develops this framework into a theory of agility and relates it to the theories that have informed the conceptual framework. Thus, it shows how this thesis contributes to the literature on organizational agility and digital infrastructures. It also outlines the other contributions, the concept of bounded agility and the conceptualization of data as facts of the world.

Chapter 8 presents an overview of the thesis, discusses contributions to theory and practice and outlines possibilities for future research.

2 Literature review

2.1 Introduction

This chapter reviews the literatures on organizational agility and digital infrastructures and outlines an approach that combines these two concepts, which would contribute to both areas. It is argued that, while organizational agility has been extensively researched in the Information Systems literature, the area could benefit from a stronger focus on the changing nature of IT as a consequence of digitalization. Similarly, research in this area has been criticised for a lack of variety with regards to the arguments constructed and the restricted role often ascribed to IT. Hence it can benefit from applying the concept of digital infrastructures. On the other hand, much research on digital infrastructures is still confined to relatively narrow areas, despite broad calls for research. Applying the concept of digital infrastructures to the area of organizational agility may be a good way to address these shortcomings. The chapter is organized as follows: In this section, the approach to the literature review is discussed. Section 2.2 outlines the context for organizational agility research in Information Systems, whereas section 2.3 synthesizes the existing Information Systems literature on organizational agility and points to areas for theoretical contributions. These include the need to reflect on changes brought about by digitalization. To address this, section 2.4 introduces the literature on digital infrastructures and outlines how it can contribute to the area of organizational agility. Section 2.5 summarises the findings and leads to a general research question, which will then be developed into more specific ones in the next chapter.

2.1.1 Method

This thesis follows Rowe's (2014) quality guidelines to undertake a systematic search and synthesis of the literature. This is used as a basis to identify gaps and challenge implicit assumptions. The idea of identifying such assumptions is elaborated by Alvesson & Sandberg (2013), who argue that this can lead to more interesting research questions. A more detailed method is described by Okoli (2012), who applies critical realist principles in order to "discern the latent theoretical concepts underlying apparently disparate empirical investigations" (p.1) and to distil

them. This, he argues, helps researchers to focus on "making a theoretical contribution from a social science perspective" (ibid.). Theories in this context are seen as mechanisms in the domain of the real that help to explain the events observed in the domain of the empirical. Based on Okoli (2012), the following literature review protocol has been devised:

- Purpose: Theory landscaping
    - The literature review will be conducted in order to understand and synthesize the theories on organizational agility that have been brought forward so far.
- Protocol and Training
    - plan that describes the conduct of a proposed systematic literature review
- Synthesis
    - In the synthesis of the literature, the focus will be on the concepts used in existing research and the relationships proposed between them, with a particular focus on explanations on how agility is supported in organizations.
- Practical Screen
    - The literature review will focus on papers from top journals and conferences in IS, as well as relevant papers from related disciplines. It will include papers referenced by those where appropriate.
    - Specifically, the focus is on papers about organizational agility, rather than other aspects of agility.
    - For the synthesis of literature, it will focus on papers with empirical findings.
- Search
    - Search will be conducted using appropriate databases like Scopus or Web of Science, as well as conference websites.
- Quality Appraisal
    - Papers will be rated and given appropriate weight in the literature review based on their explanatory power.
- Data Extraction
    - The following data will be extracted from the texts:
        - Constructs and conceptualization – concepts and relationships
        - Research approaches
        - Factors/ mechanisms supporting agility
        - The role of IT

Figure 1 Literature review protocol

Thus, the literature review aims at identifying and synthesizing theories used to explain organizational agility. For this, concepts and the relationships proposed between them will be extracted from the literature. There will be a focus on how IT is conceptualized and what factors are seen to support agility. The review looks at empirical rather than conceptual papers, as the interest lies in the way agility has been researched in real-world scenarios.

2.2 Organizational agility in the context of IS strategy research

This section outlines the context for organizational agility research in Information Systems by relating it to similar streams in other areas and placing it in the wider context of Information Systems strategy.

2.2.1 Management research

The concept of organizational agility originated in management research in the 1990s (Goldman et al. 1994), when it was seen as a reaction to a perceived increase in competitive pressures. Highsmith (2002) speaks of "the change-driven economy" and argues that agile development matches the business need to deal with speed and change, and thus forges "the workforce culture of the future" (p. 4). He extends his view of agility from software development to the whole organization and sees this agility as a competitive advantage: "agile organizations create chaos for their competitors, first by creating change so fast that competitors are left gasping for breath; and second, by responding quickly to competitors' attempts to change the market" (p. 5). Similarly, Sharifi & Zhang (2001) propose agile manufacturing as a response to "an evolutionary transformation of [the] business environment, with change as a main characteristic" (p. 772). They see the main issue for firms in "the ability to cope with unexpected changes, to survive unprecedented threats in the business environment, and to take advantage of changes as opportunities" (p. 773). It remains unclear though what is new about agility, as they point out that "enterprises have always had to deal with continuous change in their operational environment in order to remain competitive" (p. 772).

2.2.2 Software development

Well before it was applied in the area of Information Systems research, the concept of agility was transferred from manufacturing to software development (Mathiassen & Pries-Heje 2006). The concept of agile software development (Fowler & Highsmith 2001) was a reaction to the desire of a group of software developers to work faster and more flexibly by avoiding some of the formalities of traditional software development. This is interesting in several ways: firstly, it shows that agility is not about technology, but about ways to manage it. Also, there is a strong focus on social interactions and a desire to get away from formalism for the benefit of increased flexibility. Similar ideas will be discussed in relation to the area of organizational agility.

Even though agile development appears to be quite different from organizational agility or strategy, efforts have been made to link the concepts. Baskerville (2006) shows some of the similarities between software development and management (e.g. planning and control). He points out that non-agile approaches to software development are sometimes called "plan-driven" (e.g. Williams & Cockburn 2003) and asks if agility is therefore the opposite of planning. He argues instead for the paradox of planned serendipity, citing the example of theatre companies that have to plan for constant innovation within tight deadlines (Austin & Devin 2003).

Since agile development was driven by practitioners, there have been some concerns about the rigour of research on it. Looking at the area of Information Systems development (ISD), Conboy (2009) points to a number of conceptual problems, including lack of clarity (e.g. due to different definitions of agility), lack of theoretical glue and lack of parsimony. He outlines a framework to address these issues:

> Taxonomy of ISD Agility
>
> 1. To be agile, an ISD method component must contribute to one or more of the following:
>   i. creation of change
>   ii. proaction in advance of change
>   iii. reaction to change
>   iv. learning from change

2. To be agile, an ISD method component must contribute to one or more of the following, and must not detract from any:
    i. perceived economy
    ii. perceived quality
    iii. perceived simplicity
3. To be agile, an ISD method component must be continually ready i.e. minimal time and cost to prepare the component for use.

(Conboy 2009, p.341)

This is useful as it helps to clarify the expectations associated with the concept of agility. It will also help later to conceptualize agility in organizations.

2.2.3 Research field: Information Systems strategizing

Information Systems research on organizational agility can be placed in the tradition of Information Systems strategy research as its main interest is in how information systems can support an organization's strategic goals. This has been a central concern of the Information Systems field since its beginnings (Avgerou 2000; Galliers 2007). The field started out with rational conceptualizations of IT and organizations following a view of administrative rationality, e.g. based on Porter's (1979) five forces framework or the resource based view of the firm (Barney 1991; Wade & Hulland 2004). One broadly used example of such an approach is the concept of alignment, the idea that Information Systems strategy should support the business strategy (Henderson & Venkatraman 1993), which has been a central concern. This stresses the importance of IT for business strategy: an important factor for success is "the capability of an organization to exploit [IT] functionality on a continuous basis" (p. 473). Yet while Henderson & Venkatraman draw a nuanced picture arguing for a dynamic, constantly adapting view of strategic fit, the idea of alignment has often been used in an overly simplified way. This has repeatedly been criticised: Ciborra (2000) argues for 'drift', i.e. less top-down control and more trust in self-organization. Similarly, Tanriverdi et al. (2010) argue that, in a world of complex adaptive business systems, the main quests of Information Systems strategy need to change. Instead of alignment, they propose looking at co-evolution to "increase a firm's agility and dynamism" (p. 822). This appears to be a useful approach as it moves from a primacy of business strategy (implied in the concept of alignment) to a focus on the relationship between Information Systems and business strategy, and how

they shape each other. Such research generally sees IT as a separate, contained entity that the business can use to achieve its purposes. This is reflected in the view of IT as a capability (e.g. Chen et al. (2014) following Bharadwaj (2000)). Yet these rational views have their limits, as argued by Mathiassen & Stage (1992). They follow (Simon 1957) in arguing that rationality is bounded, as humans have limited knowledge and so employ heuristic search ("trial and error") as the principal engine for problem solving. Mathiassen & Stage define uncertainty and complexity as the factors limiting rationality.

Beyond such rationalist approaches, there is a tradition of using social theories to analyse the role of information systems in organizations. It has long been argued that "we need to move away from the very simplistic notion that IT 'drives', 'forces', or even merely 'enables' change" (Wagner & Newell 2011, p.395) and "we need to explore the complex relationship of reciprocal causality between IT and organization" (ibid.). Socially-embedded perspectives look at how people make sense of a new technological intervention and consequently see organisational change as emergent rather than as a planned activity. This includes the work of Orlikowski (e.g. 2000), who argues that when studying technology use, researchers should shift their focus from technology to human action. In this view, users create "technologies-in-practice", structures of use, which are based on technology, but also shape it in turn. Contrary to the positivist views of rationalist research, such research often follows an interpretivist epistemology. While there is an established tradition of research using social theories in Information Systems (e.g. Land & Hirschheim 1983; Walsham 1993), Howcroft et al. (2004) point out that the social shaping of technology approach is not used much in Information Systems overall – despite being "almost an orthodoxy" (p. 329) in sociology. They show how the social elements of an information system should always be considered in its design and management:

> [The Social Shaping of Technology Approach's] advocates… argue that there is no such thing as a social problem that does not have technological components; nor can there be a technological problem that does not have social components, and so any attempt to make such a division is bound to fail. They suggest that the development of technological devices should be interpreted within an analysis of the struggles and growth of 'systems' or 'networks'. (p. 330)

Thus, it is useful to apply a sociotechnical perspective as the role of people and organizations in the use of information systems should not be neglected. This also suggests that an interpretivist epistemology is beneficial (Walsham 1993).

Finally, as the above quote shows, the view of IT as a separate entity has been questioned. This has recently culminated in the concept of sociomateriality, which claims that the technical and the social are inseparable and that "humans/ organizations and technology are assumed to exist only through their temporally emergent constitutive entanglement" (Orlikowski & Scott 2008, p.457). This is partly a reaction to (legitimate) concerns that Information Systems researchers have tended to ignore the role of the IT artefact in their research (Orlikowski & Iacono 2001). While this is a useful argument, this line of reasoning will not be followed here as it is argued that, in this case, the sociotechnical concept of digital infrastructures is more suitable to explain the relationship between a historically grown information system and its users in an organization while ensuring the technical side of such systems remains at the centre of attention.

There is an on-going debate on the identity crisis in Information Systems research (Baskerville & Myers 2002; King & Lyytinen 2006; Benbasat & Zmud 2003; Grover & Lyytinen 2015), partly due to the identity of the field and partly due to the perceived lack of original theories. The field is currently trying to conceptualize the changes brought by new, modular and generative technologies (Tilson et al. 2010; Yoo et al. 2010; Fichman et al. 2014) and debating how to develop a stronger profile based on original theories (Grover & Lyytinen 2015). Indeed, it seems that the role of IT in organizations has become more important in recent years, with digitalization leading to new technologies like mobile computing (Sørensen 2011a), cloud computing (Venters & Whitley 2012) and more modular systems in general (Yoo et al. 2010). Thus, there is an increasing need for research on the interrelationship between IT and the organization. It is argued here that these changes could be articulated in a deeper way in Information Systems strategy research.

2.2.4 Placing agility in the context

Thus, there is great interest in the topic of organizational agility, both from the practitioner side and from Information Systems research. This is unsurprising as the idea of being able to react more swiftly to changes sits at the heart of competitive

activities as well as the debate on whether or not IT can matter for an organization. However, while there is a clearer notion of agility emerging, there are still multiple interpretations of the term. As mentioned before, Conboy (2009) criticises research on information systems development, among other things, for not coming up with a clear definition of agility. This can be said about organizational agility research as well. As Singh et al. (2013) put it, the concept "has received neither a consistent treatment in the literature nor a coherent typology or theory of its meaning (i.e., what it is) and significance (i.e., why it matters) to guide a systematic program of research" (p. 3). It seems like this may not be possible either. It may be hard to pin down the specific qualities of agility, given that companies have always sensed what happens around them and responded to it. Thus, rather than trying to measure agility, this thesis adopts the view that it may make more sense to see it as a relative, relational quality based on people's subjective perceptions. Examples for this view will be presented in section 2.3.4.

As a term, agility needs to be distinguished from several related concepts. Overby et al. (2006) point out that strategic flexibility is similar to agility, as it is defined as "the organizational ability to manage economic and political risks by promptly responding in a proactive or reactive manner to market threats and opportunities" (p. 122). Organizational agility, however, relates not just to strategic issues, but also to tactical and operational ones.

The concept of ambidexterity somewhat overlaps with agility. Ambidexterity is defined as "[t]he ability to simultaneously pursue both incremental and discontinuous innovation" (Tushman & O'Reilly 1996, p.24). As organizations (and their IT) grow over time, they are increasingly faced with the challenge of how to innovate while at the same time not endangering their traditional business. Ambidexterity combines the notion of agility, quickly adapting to change, with the concern for maintaining business operations. It is also the key element in Galliers' (2004; 2007) framework for Information Systems strategizing. Galliers sees it as a combination of traditional Information Systems strategy (exploitation) and agile elements (exploration). There is some empirical research to support the notion that striving for ambidexterity can be beneficial (e.g. He & Wong 2004). There have been several attempts to combine the concepts of agility and ambidexterity: Lyytinen & Rose (2006) use

exploration and exploitation as different types of agility ("two modes in which ISD organizations sense, adapt and draw upon IT innovations", p. 186). Likewise, Lee et al. (2015) posit IT ambidexterity, "the dual capacity to explore and exploit IT resources and practices" (p. 398), as an enabling factor of organizational agility. Regarding the question of how the notions of exploitation and exploration should be combined, Birkinshaw & Gibson (2004) argue for a shift from structural ambidexterity, where separate teams work on such innovative activities while decisions are being made at the top, to contextual ambidexterity that is built into the organization as individuals can make their own choices. Wang & Rafiq (2014) show how contextual ambidexterity can be supported by organizational culture. These concepts are useful, but it can be questioned how relevant they are in practice as they refer to extreme situations describing a potentially more complex endeavour.

While the term 'organizational agility' is not used consistently, it has nevertheless been used successfully in research using definitions like the one by Overby et al. (2006, p.120), who see it as "the ability of firms to sense environmental change and respond readily". This is broadly aligned with other definitions in the literature (Kharabe & Lyytinen 2012; Chakravarty et al. 2013; Huang et al. 2014). The ongoing interest of both researchers and practitioners shows that the concept is seen as useful. Ambidexterity, on the other hand, can be seen as a broader concept that contains ideas similar to agility (exploration), as well as more traditional ideas on strategy (exploitation). It also serves to connect organizational agility to the area of Information Systems strategy, as evidenced in Galliers' framework.

As mentioned, Information Systems strategy research relates to the question of how information systems can support an organization's success. Organizational agility, as a subset of this, has received significant interest recently. It is deemed relevant as an example of how information systems can help speed up the running of a business, and thus support the business in its strategic goals.

The next section will look specifically at recent Information Systems research on organizational agility.

2.3 IS research on organizational agility

This section will synthesize the Information Systems literature on organizational agility to identify common themes and approaches and point to areas for theoretical contributions. Table 1 (p. 33) gives an overview of important empirical papers in the area.

2.3.1 Introduction

The work of Orlikowski connects organizational agility to broader themes of research. Looking at the broader topic of organizational transformation, she questions received views of organizational thinking dominated by a focus on stability. She sees change as inherent and argues for a situated change perspective based on work practices:

> Because it is grounded in the micro-level changes that actors enact over time as they make sense of and act in the world, a practice lens can avoid the strong assumptions of rationality, determinism, or discontinuity characterizing existing change perspectives. (Orlikowski 1996, p.63)

Orlikowski acknowledges "visions of agile manufacturing" (p. 63) and sees them as evidence for her claim that "stability is out, change is in" (ibid.).

Despite these early works, it took a while for the concept of organizational agility to be taken up more broadly by Information Systems researchers. As late as 2006, Mathiassen & Pries-Heje find that, while agile development had been broadly researched in Information Systems, this was not the case for organizational agility. They point out that the value of IT will be questioned more in times of economic downturns as "organizations are balancing their IT spending, seeking to become better positioned (more agile) in preparation for the next economic expansion" (p. 117). This is interesting as it points to agility as a measure of cost cutting. There is indeed considerably more research on organizational agility in the Information Systems field now, a few years after the financial crisis began in 2008. This is evidenced in the literature reviews by Singh et al. (2013) and Salmela et al. (2015). The latter paper identifies seven fields of research:

- Strategic IS management
- Business agility and the value of IS applications

- Design of IT infrastructure
- Skills and competences of IS professionals
- Design and governance of the IS organization
- Methods used in IS development
- Methods used in SW development and programming

This thesis will focus on the area of business agility and the value of IS applications, which is not covered in detail by Salmela et al. (2015) as their focus is on "change capabilities of the IS organisation" (p. 2). Instead, they point to Overby et al.'s (2006) prior literature review.

2.3.2 Conceptualizing organizational agility

The following sections look at important recent papers on organizational agility published in Information Systems top journals and conferences, with a focus on empirical research. The list has been extended by some significant older papers. Looking at the ways organizational agility has been conceptualized in Information Systems research shows that authors deal with various aspects, labelled organizational agility (most common – see Lu & Ramamurthy (2011) for a discussion of earlier works), operational agility (Huang et al. 2014), business agility (van Oosterhout et al. 2006) or customer agility (Roberts & Grover 2012). In conceptualizing these terms, many authors refer to a sense-and respond framework, although some only focus on the aspect of responding (Chen et al. 2013; Fink & Neumann 2007; van Oosterhout et al. 2006). The idea of speed is common, with authors pointing out that sensing and/ or responding should happen quickly (Roberts & Grover 2012), swiftly (Lyytinen & Rose 2006; van Oosterhout et al. 2006), "with speed and surprise" (Sambamurthy et al. 2007; Schnackenberg et al. 2011) or "with ease, speed, and dexterity" (Tallon & Pinsonneault 2011).

Paper	Construct label	Construct conceptualization
Börjesson et al. 2006	agility	ability to respond to environmental events is hence the essential and distinguishing feature of the agile organization
Chakravarty et al. 2013	organizational agility	following Overby et al. 2006: agility as a strategic capability
Chen et al. 2014	business process agility	ease and speed with which firms can alter their business processes to respond to threats in their markets (Tallon, 2008)
Choi et al. 2010	IS agility	ability to quickly make changes to IT applications in response to changing business conditions
Ciborra 1996	platform	a chameleon-like organization conceived as a laboratory for rapid restructuring
Fink & Neumann 2007	IT-dependent organizational agility	ability to allow a firm to adapt successfully to changes in the external environment – multidimensional construct comprising IT-dependent system agility, information agility, and strategic agility
Holmqvist & Pessi 2006	agility	ability to sense and respond rapidly
Hovorka & Larsen 2006	agile adoption practices	agility: ability to detect opportunities for innovation and seize ... opportunities by assembling requisite assets, knowledge and relationships' (Sambamurthy et al, 2003)
Huang et al. 2014	Operational agility	capability that enables organizations to sense changes in turbulent business environments, as well as conceive appropriate competitive actions to seize market opportunities
Kharabe & Lyytinen 2012	organizational agility	ability to detect and respond to opportunities and threats with ease, speed, and dexterity
Lu & Ramamurthy 2011	organizational agility	firm's ability to cope with rapid, relentless, and uncertain changes and thrive in a competitive environment of continually and unpredictably changing opportunities
Lyytinen & Rose 2006	Information system development (ISD) agility	an ISD organization's ability to sense and respond swiftly to technical changes and new business opportunities.
Mathiassen & Vainio 2007	dynamic capabilities	help organizations to adapt to the changes in their environment
Ngai et al. 2011	supply chain agility	organization's ability to respond to unexpected market changes and convert these changes to business opportunities
Richardson et al. 2014	Enterprise agility	proposes a positive connection between a firm's IT-related decisions, level of agility, and business success (Sambamurthy et al., 2003)

Paper	Construct label	Construct conceptualization
Roberts & Grover 2012	customer agility	degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. Agility as dynamic capability
Sambamurthy et al. 2007	organizational agility	referencing Sambamurthy et al (2003) - ability to detect and seize market opportunities with speed and surprise
Tallon & Pinsonneault 2011	organizational agility	ability to detect and respond to opportunities and threats with ease, speed, and dexterity
Tallon 2007	business process agility	ease and speed with which firms can alter their processes to respond to threats or opportunities in their markets
van Oosterhout et al. 2006	business agility	being able to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage unpredictable external and internal changes
Zheng et al. 2011	collective agility	attribute emergent from the day-to-day practices of social actors; performance

Table 1 Conceptualizations of organizational agility in IS research

Existing research looks at questions like how to develop superior firm-wide IT capability to successfully manage IT to realize agility (Lu & Ramamurthy 2011), how agility can be measured (e.g. Overby et al. 2006) or the ways IT impacts firm performance (Sambamurthy et al. 2003). This has led to a good understanding of factors supporting agility in organizations, e.g. organizational control (Huang et al. 2014), learning capabilities (Lyytinen & Rose 2006) or IT capability (Lu & Ramamurthy 2011; Chen et al. 2013).

Agility is usually defined using a number of similar terms. It is commonly conceptualized as an ability (Overby et al. 2006; Tallon & Pinsonneault 2011; Lu & Ramamurthy 2011), capability (Huang et al. 2014), or degree (Roberts & Grover 2012). Thus, it is seen as something that exists in an organization to be measured and used as the basis for quantitative statements like "[a] positive link between alignment and agility applies to all firms" (Tallon & Pinsonneault 2011). For example, Roberts & Grover (2012) hypothesize a model of relationships between IT infrastructure, agility and competitive success, and test their hypotheses in an empirical survey of marketing managers. They conclude that "a Web-based customer infrastructure

facilitates a firm's customer-sensing capability; furthermore, analytical ability positively moderates this relationship" (p. 231). Likewise, (Sambamurthy et al. 2007) develop a detailed measurement model for organizational agility using organizational and IT capabilities as independent variables, entrepreneurial and adaptive agility as intermediate outcomes, and profitability, competitive position and barriers to erosion as dependent variables. These are then measured in a large-scale survey.

The concept of agility as a capability has been developed in several ways. A useful extension is the view of agility as a dynamic capability. Roberts & Grover (2012) draw this concept from the evolutionary theory of the firm (Nelson & Winter 1982). The key idea is that capabilities need to be adapted continually:

> Since managers make decisions under uncertainty and are boundedly rational, they satisfice rather than optimize in searching for and selecting solutions to problems. The implication is that firms should continually reconfigure their existing capabilities. (Roberts & Grover 2012, p.237)

Eisenhardt & Martin (2000, p.1107) define dynamic capabilities as "organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die." Dynamic capabilities, however, are not always easy to differentiate from agility: Mathiassen & Vainio (2007) use the terms almost synonymously. Conversely, Overby et al. (2006, p.121) clearly distinguish between the two concepts:

> The dynamic capabilities concept is relevant to all types of firm processes, whereas enterprise agility includes only those processes relevant for sensing and responding to environmental change. In a sense, enterprise agility can be thought of as being enabled by a specific subset of dynamic capabilities.

Thus, the concept addresses a weakness of the resource based view, its static nature. Moreover, the recognition of the limits of rationality in the daily practice of management seems to be particularly useful. An alternative conceptualization of agility that has a similar focus on activities in organizations is proposed by Zheng et al. (2011), who define collective agility as a performance, "an attribute emergent from the day-to-day practices of social actors" (p. 305). They contrast this with the received views of "agility as empirically validated small group methods and practices" (p. 305) and "agility as an organizational capability" (bid.), which amount to the practices generally called 'agile software development' (Fowler & Highsmith

2001), as well as to the concept of organizational agility (they refer e.g. to Highsmith 2002):

> We develop a third and distinct perspective, what we call *collective agility* seen as a 'structuring property' (Giddens, 1984) of a collective, instantiated in improvisational behaviour of individuals and groups and in their social interactions. In other words, collective agility is an attribute emergent from the day-to-day practices of social actors. We thus explore agility as a *performance*. (p.305, italics in original)

The authors describe agility as "an expression of what people do or achieve, rather than what they might do or capabilities they hold" (p. 329). This shifts the focus of research to the practices in an organization, where agility is seen as the result of a socio-technical process. This thesis will adopt this conceptualization as it overcomes some of the limitations of traditional views on agility discussed before, like the contrast between dynamic information needs and static technology described by Galliers (2011). Moreover, the focus on performances enables more dynamic conceptualizations of information systems, as illustrated by Zheng et al.'s (2011) case study, which looks at a computing grid for particle physics supporting the Large Hadron Collider at CERN, the European laboratory for particle physics.

2.3.3 Research based on quantitative data

The next two subsections look at the methods employed in existing research, as well as the general approaches to researching organizational agility in the existing Information Systems literature.

Research approaches to organizational agility reflect the development of the area of Information Systems strategy research outlined above. There is a long debate in the social sciences on how to label and differentiate the two commonly used traditions of research. As discussed before, research on Information Systems strategy can be broadly separated into research taking a rationalist view of the world (usually applying a positivist epistemology) and research in the tradition the social sciences (usually applying an interpretivist epistemology). This distinction is often reflected in the kind of data collected: While positivist research generally uses quantitative data (e.g. gained through a large-scale survey and analysed using statistical methods), interpretivist research mostly uses qualitative data (e.g. gained through a case study and analysed using interpretive methods). Since authors are not always

explicit about their choice of epistemology, this thesis instead distinguishes the empirical papers based on their choice of data collection. There have been long and heated debates around which approach is more useful (e.g. Goertz & Mahoney 2012). Some consensus seems to be emerging that a less dogmatic view is called for. King et al. (1994) even argue that the logic of inference is the same for both styles of research:

> the differences between the quantitative and qualitative traditions are only stylistic and are methodologically and substantively unimportant. All good research can be understood – indeed, is best understood – to derive from the same underlying logic of inference. Both quantitative and qualitative research can be systematic and scientific. (p. 4 f.)

Whatever the case may be, it seems appropriate to appreciate the strengths of both styles of research and apply both, depending on which one is more useful for a specific research project. However, there are significant methodological questions connected to the choice of research style. These will be discussed in more detail in Chapter 4. For now, research on organizational agility following these two traditions is discussed and compared.

Much of existing Information Systems research on organizational agility is based on statistical analysis of quantitative data (see Table 2 for an overview). It applies the corresponding methods, e.g. surveys (Roberts & Grover 2012; Kharabe & Lyytinen 2012; Chen et al. 2013), regression analysis (Chakravarty et al. 2013) or quantitative field studies (Lu & Ramamurthy 2011; Fink & Neumann 2007). This implies a positivist stance and a search for a fixed truth. This is in line with the majority of Information Systems research in general: as Mingers (2004b) points out, statistical analysis in the positivist tradition remains "the dominant research method within IS" (p. 97).

Paper	**Theories used**	**Type of data**	**Methods**
Börjesson et al. 2006	diffusion of innovation, software agility	mixed	action research
Chakravarty et al. 2013	finite mixture theory	quantitative	regression analysis
Chen et al. 2014	resource based view	quantitative	survey
Choi et al. 2010	system dynamics	quantitative	model, simulation
Ciborra 1996	structuration (Giddens), sensemaking (Weick)	qualitative	case study

Paper	Theories used	Type of data	Methods
Fink & Neumann 2007	IT infrastructure, capabilities	quantitative	field study, quantitative survey
Holmqvist & Pessi 2006	technology diffusion, logistics research	qualitative	case study, interpretive
Hovorka & Larsen 2006	network processes, knowledge acquisition	qualitative	case study
Huang et al. 2014	information processing	qualitative	case study
Kharabe & Lyytinen 2012	innovation assimilation, KBV, capabilities based view	quantitative	survey
Lu & Ramamurthy 2011	IT capability	quantitative	field survey
Lyytinen & Rose 2006	IT innovation, organizational learning	quantitative	longitudinal case study, qualitative
Mathiassen & Vainio 2007	RBV, dynamic capabilities, sense-and-respond	qualitative	qualitative case study
Ngai et al. 2011	RBV	qualitative	multi-case study
Richardson et al. 2014	digital options	qualitative	case study
Roberts & Grover 2012	dynamic capabilities, IT business value, alignment	quantitative	survey of marketing executives of high-tech firms
Sambamurthy et al. 2007	organizational IT impact	quantitative	field survey
Tallon & Pinsonneault 2011	strategic IT alignment	quantitative	survey
Tallon 2007	RBV	quantitative	survey
van Oosterhout et al. 2006	previous research on agility	mixed	survey + qualitative data from interviews
Zheng et al. 2011	organizational performance, sensemaking, paradox	qualitative	case study

Table 2 Research designs

Statistical analysis has enabled authors to propose a number of relationships around agility, including:

- "while more IT spending does not lead to greater agility, spending it in such a way as to enhance and foster IT capabilities does." (Lu & Ramamurthy 2011, p.932)
- "alignment between customer-sensing capability and customer-responding capability will impact the firm's competitive activity" (Roberts & Grover 2012, p.231)

- "positive and significant link between alignment and agility and between agility and firm performance. We also show that the effect of alignment on performance is fully mediated by agility, that environmental volatility positively moderates the link between agility and firm performance, and that agility has a greater impact on firm performance in more volatile markets." (Tallon & Pinsonneault 2011, p.463)

Such research has produced useful findings. Singh et al. (2013) argue that "agility is best viewed as an organizational capacity to produce change along two dimensions that are posited to be typically in tension: (1) magnitude, and (2) rate of variety" (p. 3). This means it can be measured, which they do based on the dimensions given above, e.g. by looking at the release cycles and the amount of innovation (e.g. new features) in smartphones. The correlation, however, is not always this straightforward: van Oosterhout et al. (2006) see IT as both a potential enabler and disabler of organizational agility, as legacy systems can get in the way of agility initiatives. Kharabe & Lyytinen (2012) investigate whether ERP systems promote or hinder organizational agility, finding evidence in the literature for both. They find that ERP assimilation (i.e. the extent to which it gets taken up and diffused across the organization) positively influences organizational agility, and find that systems agility also positively influences organizational agility, as well as strengthening the impact of ERP assimilation on organizational agility. Chakravarty et al. (2013) contribute to a better understanding of how information technology competencies shape organizational agility and firm performance, arguing that they play both an enabling and a facilitating role. Similarly, Chen et al. (2013) point out that IT capability does not directly lead to better firm performance and stress the role of business processes and environmental factors.

Some researchers have taken issue with such rational approaches. Ciborra (2004) criticises them for assuming a "geometrical" universe based on the ideas of rational planning and building of (static) information systems to align with business strategy. Such criticism does have a point: As an example, Roberts & Grover (2012) hypothesize a model, based on existing literature, to propose a number of relationships leading to increased customer agility and competitive activity. They then conduct a survey of marketing executives of US high-tech firms to test these hypotheses.

Respondents were asked how much they agreed with statements like "We sense our customers' needs even before they are aware of them" (p. 263). Results from the survey are statistically analysed, with five out of six hypotheses supported by the findings (p. 252). Thus, their hypothesized relationships are empirically supported and can serve as a basis for future research. On the other hand, a question like "We sense our customers' needs even before they are aware of them" will lead to answers that are affected by respondents' personal views of the matter, and not as neutral as the approach makes them out to be. Thus, such statistical approaches may be less rational than they claim to be. Yet Roberts & Grover themselves also reflect on the limits of such rationality: They conceptualize agility as a dynamic capability, which, as discussed, implies the fact that managers continuously reconfigure the capabilities in an organization as they "satisfice rather than optimize in searching for and selecting solutions to problems" (p. 237).

2.3.4 Research based on qualitative data

In contrast to the predominant research using quantitative data, some papers focus on the interpretation of qualitative data. This is usually associated with the corresponding methods, e.g. case studies (Huang et al. 2014; Zheng et al. 2011; Mathiassen & Vainio 2007; Schnackenberg et al. 2011), and often employs an interpretivist epistemology. As pointed out, there is a considerable stream of interpretivist research in Information Systems. This stems from the view that "our knowledge of reality, including the domain of human action, is a social construction by human actors" (Walsham 2006, p.320). Research thus needs to understand, and critically engage with, the processes of such constructions.

A good example for this is Ciborra (1996). He looks at organizations that are able to "efficiently generate new combinations of resources, routines and structures which are able to match the present, turbulent circumstances" (p. 104). He compares such organizations to a computer platform that enables the recombination of standardized components. This shows that not only is the concern about "turbulent circumstances" nothing new, but there have been imaginative ways to conceptualize the role of information systems in organizations before. While not directly referring to agility, he argues that the platform organization "should be appreciated as a necessary culture bed for experimentation and recombination" (p. 116). Indeed, Ciborra (2000)

discusses the limitations of the traditional (positivist) view of IT infrastructure and argues for a shift "from control to drift", for seeing infrastructure as a relation that is heterogeneous, open and growing. Instead of planned alignment and top-down control, he argues that tinkering (Ciborra 1992) and improvisation (Ciborra 1999) are far closer to the reality in the daily workings of companies. This example illustrates the possibilities of interpretivist research, as Ciborra has reached a thorough understanding of the case, then proceeds to offer an alternative interpretation to generate new insights.

Looking at papers based on qualitative data in detail shows that some of them do not differ that much from those based on quantitative data. E.g. Ngai et al. (2011) propose a model and hypotheses, then proceed to test these. Unlike the papers based on quantitative data, they use case studies rather than surveys to collect their data, but the logic of inference remains quite similar. Other studies also develop explanatory models (Hovorka & Larsen 2006; Huang et al. 2014), but reflect more on the growing understanding the authors have developed during their studies. Most authors make a point of collecting data from a variety of sources (e.g. Mathiassen & Vainio 2007; Huang et al. 2014; Hovorka & Larsen 2006). This data is then usually analysed in an incremental process, following recommendations like the ones given by Miles & Huberman (1994). This enables researchers to start with a hypothesized model, then refine it based on findings from the case study (e.g. Hovorka & Larsen 2006; Huang et al. 2014) to reach a better understanding of the case. As an example, Zheng et al. (2011) employ an interpretivist epistemology as they interpret the development of a global computing grid for particle physicists as a collective performance enabled by culture and the navigating of paradoxes. They conceptualize agility as a sensemaking effort that depends on the users' interpretations of their work context. Thus, they relate to Weick (1995), who theorized that active agents in organizations construct sensible, senseable events through their beliefs and actions. In this view, organizations become "social structures that combine the generic subjectivity of interlocking routines, the intersubjectivity of mutually reinforcing interpretations, and the movement back and forth between these two forms by means of continuous communication" (p. 170).

Assuming that members of organizations are indeed involved in such acts of interpretation and sensemaking, it becomes clear why an interpretivist epistemology is useful. Interpretivist research can achieve a richer understanding of the context in which information systems are used, and take a broader view of their role in organizations. It seems very relevant for the area of organizational agility, as it does not attempt to reduce the complexity of an organization to measurable factors, but instead tries to understand the socio-technical processes supporting it.

2.3.5 The role of IT

The different ways to conceptualize and research organizational agility also have an impact on the way researchers see the role of IT in organizations. Table 3 gives an overview.

Paper	**Role of IT**
Börjesson et al. 2006	part of context/ object of study. Does not directly affect agility
Chakravarty et al. 2013	enabling and facilitating
Chen et al. 2014	supporting agility
Choi et al. 2010	supporting agility
Ciborra 1996	shifts in technology speed up changes in identity
Fink & Neumann 2007	organizational capability, can support agility
Holmqvist & Pessi 2006	part of context/ object of study. Does not directly affect agility
Hovorka & Larsen 2006	supporting agility
Huang et al. 2014	enhances information processing capability, which in turn supports agility
Kharabe & Lyytinen 2012	promoting or hindering agility
Lu & Ramamurthy 2011	can enable or hinder agility
Lyytinen & Rose 2006	part of context/ object of study. Does not directly affect agility
Mathiassen & Vainio 2007	capability that supports adapting to environment
Ngai et al. 2011	IT competence as part of supply chain competence, supporting supply chain agility

Paper	Role of IT
Richardson et al. 2014	supports agility, increases social value generation
Roberts & Grover 2012	enabling, enhancing (by supporting these synergies) - "tool view"
Sambamurthy et al. 2007	enabling agility
Tallon & Pinsonneault 2011	can support agility
Tallon 2007	driving agility
van Oosterhout et al. 2006	can be change factor or enabler/ disabler
Zheng et al. 2011	Grid infrastructure creating a sense of community

Table 3 Conceptualizations of IT

As in the example of the Roberts & Grover (2012) paper above, positivist research based on quantitative data is often looking for statistical correlations to identify factors supporting agility. Such research tends to imply a view of IT as a tool to reach certain business purposes. Roberts & Grover (2012) explicitly subscribe to the "tool view of IT" (p. 237), described as "the common, received wisdom about what technology is and means" by Orlikowski & Iacono (2001, p.123). Some papers based on qualitative data take similar approaches: Ngai et al. (2011) develop a similar model in which they see IT competence as a part of supply chain competence, which in turn supports supply chain agility. Similarly, Huang et al. (2014) conceptualize information processing capability as supporting operational agility. Thus, the role of IT as a potential enabler or hindrance for agility in organizations is well understood. There are some examples, however, that show how taking a different view of the role of IT in organizations can lead to new insights. Richardson et al. (2014) see IT as "a 'strategic integrator' that increases social value creation (…) by facilitating resource integration among [social enterprises] working toward similar social missions" (p. 24). Mathiassen & Vainio (2007) see IT as a capability that supports organizations in adapting to their environment. Ciborra (1996) goes further as he reflects on processes of sensemaking and construction of identity and discusses how shifts in technology can speed up changes in identity. Finally, Zheng et al. (2011) research the role of a grid infrastructure for distributed researchers in creating a sense of commu-

nity. This shows that the way IT is conceptualized has a significant impact on research and can thus point to potential areas for contributions.

2.3.6 Synthesis and areas for contribution

Organizational agility has been broadly researched in the Information Systems literature, leading to a good view of the concept and many relevant results. The concept also seems to appeal to practitioners. It is best placed in the wider area of Information Systems strategy research, and this is where this thesis hopes to contribute. Agility has been conceptualized as an ability or capability in organizations and its existence is not usually questioned. Also, most research to date follows a positivist epistemology and is based on quantitative data analysis. This has led to a good understanding of the area.

There are nevertheless also some areas for contribution emerging from the literature review. It has been shown at the outset of this thesis that existing Information Systems literature on organizational agility is criticised for a lack of variety (Salmela et al. 2015). While Salmela et al. focus only on some aspects of Information Systems research on agility, similar criticism can be raised about the broader research area. As discussed, much research is focussed on quantitative data and statistical analysis, while also some qualitative research sticks to defining cause-effect relationships. There is an opportunity for qualitative research to focus more on an understanding of the processes at play rather than measuring subjective opinions in surveys. Moreover, given the debate on the identity crisis in Information Systems research mentioned above, it appears the field would benefit from more variety in research and a clear profile based on its own theories.

This lack of variety is reflected in the way agility is conceptualized. Alvesson & Sandberg (2013) point out that it can be useful to identify and question assumptions behind existing research in order to come up with new approaches. One of these assumptions is the root metaphor commonly applied by researchers in an area. As illustrated, agility is often conceptualized as an ability or capability. This implies a root metaphor of the organization as a static, concrete entity (that is able to have abilities or capabilities) and of information systems as a tool to support strategic goals. As an alternative conceptualization, this thesis adopts the concept of agility as a performance as developed by Zheng et al. (2011). This is appealing as it shifts the

focus from agility as a given quantity to the processes in sociotechnical systems, where users enact agility in response to their surroundings. As agility refers to complex processes of change, it would be useful to conceptualize it in a less static way and focus on agility as dynamic, emerging and changing. This takes up Orlikowski's idea of studying "technologies-in-practice". Here, "capabilities are not understood (…) as something held prior to a performance; rather, they are the medium and outcome of it" (Zheng et al. 2011, p.305). Agility is seen as constantly enacted, so, in order to understand it, a close focus on the processes of this enactment is required.

Finally, the world of IT has changed considerably in recent years. With technological progress, seen for example in the growth of networked, mobile IT, there have been technical shifts affecting IT in organizations as well. These have been conceptualized using the terms digital convergence (Herzhoff 2009) or digitalization (Tilson et al. 2010). This thesis argues that digitalization affects the way information systems in organizations should be conceptualized, but has not been reflected sufficiently in existing research on organizational agility. This is an underlying reason for the traditional conceptualizations of information systems identified in the literature review. An emerging stream of research conceptualizes information systems as digital infrastructures that are heterogeneous and evolving. This thesis applies the concept to the area of organizational agility. This could lead to a new focus on the processes of emergence, evolution, and the conflicts around digital infrastructures. This literature will be discussed next.

2.4 Digital infrastructures

This section introduces Information Systems research on Digital Infrastructures and shows how it could contribute to the area of organizational agility.

2.4.1 The concept

It is instructive to reflect on the reasons that motivated researchers to develop and use the concept of digital infrastructures. The technological change associated with digitalization leads to new views of the information systems artefact, which are not yet broadly reflected in the literature on agility. This thesis argues that the concept of digital infrastructures should be used to conceptualize information systems in organizations when researching organizational agility. The concept builds upon earlier

work in the tradition of European, social science based Information Systems research, including the tradition of socially embedded research (Orlikowski 2000; Avgerou & Cornford 1993) or the concept of digital artefacts. Kallinikos et al. (2010; 2013) describe these as editable, interactive, reprogrammable and distributable. The focus on the evolution of infrastructures shows the concept's debt to the tradition of research on the social shaping of technology, which, as mentioned, looks at "the struggles and growth of 'systems' or 'networks'" (Howcroft et al. 2004, p.330).

Early use of the term 'infrastructure' is characterized by a sense of managerial determinism. Broadbent & Weill (1997) argue that "an IT infrastructure provides the shared foundation of IT capability for building business applications". They later define the term as "the base foundation of the IT portfolio (including both technical and human assets), shared throughout the firm in the form of reliable services, and usually coordinated by the IS group" (Broadbent et al. 1999, p.163). There is a sense that, ultimately, management is in control of the development of infrastructures – e.g. infrastructure is conceptualized as a capability in Broadbent et al. (1999). Ciborra & Hanseth (1998) criticise such assumptions, arguing instead that infrastructure "cannot be changed instantly" (p. 310) as the installed base makes any changes difficult. They argue for a "no plan/ no strategy attitude" (p. 324) in which "infrastructure expands by the decentralized linking of local initiatives that are born as spin-offs of headquarters' initiatives" (bid.). They see technological systems as "organisms with a life of their own" (p. 312) and speak of "cultivating" (p. 312), rather than managing them. This view will be applied in the conceptual framework as it looks at the evolution of digital infrastructures and the attempts of people in the organization to influence it.

A growing literature has emerged to chart the infrastructural nature of many digital technologies. As these have developed over time, research needs to look beyond single systems and see the infrastructure of systems that has evolved. One early use of the concept of infrastructure in Information Systems research is by Hanseth & Monteiro (1998):

> The term "information infrastructure" (II) has been increasingly used to refer to integrated solutions based on the now ongoing fusion of information and communication technologies. (p.1)

They argue that while information infrastructures support changes in organizations, their installed base of technology can also constrain it. This view of infrastructure as enabling and constraining can also be found in other early research (Star & Ruhleder 1996; Star 1999). Such views reflect the growing involvement of information systems in social and economic life as they rarely are the outcomes of strategic planning. Hanseth & Lyytinen (2010) describe the Internet as an example of an evolution that is "nonlinear, path dependent and influenced by network effects and unbounded user and designer learning" (p. 1).

The paper that brought digital infrastructures to the foreground of Information Systems research is Tilson et al. (2010). They point to digital infrastructures as "the one class of IT artifacts… that underlies digital convergence" (p. 748). Following Hanseth & Lyytinen (2010), they define digital infrastructures as "shared, unbounded, heterogeneous, open, and evolving sociotechnical systems comprising an installed base of diverse information technology capabilities and their user, operations, and design communities" (p. 748f.). This shifts the focus from rational planning to the on-going evolution of infrastructures (Henfridsson & Bygstad 2013). It also shows that, due to their sociotechnical nature, digital infrastructures should be seen as consisting of IT and the people who use and design it. Hanseth & Lyytinen (2010) call the socio-technical system at the heart of such infrastructures the "installed base" (following Star & Ruhleder 1996) and point out that it can both enable and constrain the evolution of infrastructures. The focus on people, of course, is another link to the tradition of sociotechnical research.

2.4.2 Contexts

The theoretical lens of digital infrastructures has proved useful to conceptualize some of the new information systems phenomena enabled through digitalization, but has also sometimes been applied in more traditional information systems settings. The following sections look at important recent papers on digital infrastructures published in Information Systems top journals and conferences, with a focus on empirical research. These papers cover a variety of research contexts, as Table 4 shows.

Paper	Research site	Topic	Methods
Broadbent et al. 1999	4 firms (retail/ petroleum)	BPR	exploratory case analysis
Ciborra & Hanseth 1998	IBM	CRM	case study
Claggett & Berente 2012	computationally-intensive research centers	digital infrastructure innovation	case study
Eaton et al. 2015	Apple's iOS service system	iOS	case study
Grisot et al. 2013	web- based platform for patients	health	case study
Grisot et al. 2014	patient- oriented web-based solution	innovation	case study
Hanseth & Lyytinen 2010	Internet	Internet	case study
Henfridsson & Bygstad 2013	Scandinavian airline	airline	case study, case survey
Henningsson & Henriksen 2011	European e-Customs	e-government	case study
Hylving & Schultze 2013	car manufacturer	instrument cluster	case study
Iannacci 2010	criminal justice system of England and Wales	links between data standards and institutional facts	case study
Kallinikos et al. 2013	Internet Archive/ Search engines	digital artifacts	case study
Karimi & Walter 2015	senior executives of newspaper companies	newspaper industry	Survey
Kirsch & Slaughter 2013	cyberinfrastructures for Earthquake Engineering Simulation/ Network Innovations	scientific cyberinfrastructure	case study
Lindgren et al. 2015	Swedish Road Administration	traffic information service	case study
Magnusson & Bygstad 2014	Large Public University	technology heritage	case study
Obrand et al. 2012	large IT consultancy firm	risk management	case study
Racherla & Mandviwalla 2013	Philadelphia wireless initiative	Universal access to the Internet	case study
Reimers et al. 2014	China's pharmaceutical distribution industry	industry-wide information infrastructures	case study

Paper	Research site	Topic	Methods
Rodon & Silva 2015	electronic prescription II in the public healthcare sector in Spain	health	case study
Star & Ruhleder 1996	Worm Community System - supports collaborative work of geneticists	large-scale custom software	case study/ ethnography
Tilson et al. 2012	Android and iOS Mobile Operating Systems	mobile	case study
Venters et al. 2014	computing grid infrastructure for CERN particle physics community	Grid	case study

Table 4 Digital infrastructures: Topics and methods

Research often looks at areas where the infrastructural nature of the information systems is more evident (and where the concept originated), e.g. mobile IT (Tilson et al. 2012; Eaton et al. 2015), the Internet (Hanseth & Lyytinen 2010; Kallinikos et al. 2012) or embedded technology (Hylving & Schultze 2013). The concept has also been successfully applied in areas that go beyond single information systems in an organization. These include heterogeneous networks for research (Claggett & Berente 2012; Kirsch & Slaughter 2013; Venters et al. 2014), health IT (Grisot et al. 2013; Rodon & Silva 2015) and even the criminal justice system (Iannacci 2010). There is a small, but growing tradition of research on information systems in large organizations using the concept of digital infrastructures. After the pioneering work by early authors (Ciborra & Hanseth 1998; Broadbent et al. 1999), current examples focus on IT risk management (Obrand et al. 2012), the transformation of the newspaper industry (Karimi & Walter 2015) or the digital infrastructures within an airline (Henfridsson & Bygstad 2013).

2.4.3 Methods and approaches

The way digital infrastructures have been researched reflects the concept's origins in the social science based stream of Information Systems literature. Consequently, almost all papers in this analysis are based on qualitative data and interpretive methods (see Table 4 above). Of the 23 papers analysed here in detail, only one (Karimi & Walter 2015) employs statistical methods, while another one (Broadbent et al. 1999) uses mixed methods. All the remaining papers are case studies based on qualitative data usually gained through semi-structured interviews.

Finally, digital infrastructures are seen as sociotechnical, so the people using and designing them play an important part in their functioning. E.g. Claggett & Berente (2012) show how decision makers' values, represented by their attention levels, can influence digital infrastructure evolution. Thus they relate to the idea of bounded rationality, which can be seen in some of the papers on organizational agility as well (Mathiassen & Stage 1992; Roberts & Grover 2012). Venters et al. (2014) show how coordination tensions, caused by human and material inertia, can affect the evolution of an infrastructure.

2.4.4 The role of IT

As Table 5 shows, research on digital infrastructures also develops some interesting ideas on the role of IT (or digital infrastructures) in organizations. This table cannot be directly compared to Table 3 (page 42), which gave a similar overview on conceptualizations of IT in Information Systems research on organizational agility. As discussed, the concept of digital infrastructures is significantly different from earlier conceptualizations of IT, so a direct comparison is not warranted. Instead, these tables show how researchers' view of the world (or of IT) changes when the concept of digital infrastructures is applied.

Paper	**Role of IT / DI**
Broadbent et al. 1999	contributes to success - spans across e.g. firm boundaries
Ciborra & Hanseth 1998	organisms with a life of their own
Claggett & Berente 2012	can enable practices on multiple levels such as societies, industries / sectors, or organizations
Eaton et al. 2015	means of control
Grisot et al. 2013	evolving/ avoiding friction with organization
Grisot et al. 2014	cultivation of installed base leads to successful innovation
Hanseth & Lyytinen 2010	shared, open, heterogeneous and evolving socio-technical system
Henfridsson & Bygstad 2013	evolving under the right conditions
Henningsson & Henriksen 2011	IT artefacts inscribe behaviour into IIs
Hylving & Schultze 2013	potential to create a new relationship between function, form, and matter
Iannacci 2010	grammar that underpins successful communication between and among

Paper	Role of IT / DI
	disparate systems.
Kallinikos et al. 2013	digital artifacts embedded in wider and constantly shifting ecosystems
Karimi & Walter 2015	dynamic capabilities positively associated with building digital platform capabilities, which impact the performance of response to digital disruption
Kirsch & Slaughter 2013	supports transformation in the way science is conducted
Lindgren et al. 2015	participating in a mobile ecosystem can question the organization's identity
Magnusson & Bygstad 2014	constraining aspects of technology heritage impact future decisions
Obrand et al. 2012	organizational resource, intertwined with corporate strategy
Racherla & Mandviwalla 2013	digital backbone of our society
Reimers et al. 2014	IS emergence and industry consolidation mutually reinforce each other
Rodon & Silva 2015	shapes actors' capacity to innovate
Star & Ruhleder 1996	supports collaboration and organizational transformation
Tilson et al. 2012	platforms for creating service ecologies
Venters et al. 2014	dynamic interplay of generative material and social agencies, oriented to multiple dimensions of time

Table 5 Digital infrastructures: The role of IT

Some papers take a fairly traditional view of IT, seeing it as a tool that can be used rationally to achieve a purpose (Broadbent et al. 1999; Karimi & Walter 2015). This is similar to the view taken in much research on organizational agility. A central notion with the digital infrastructures view is that of IT as historically grown. Such research typically focuses on the evolution of infrastructures (Bygstad 2010; Grisot et al. 2013; Grisot et al. 2014).

Research on digital infrastructures generally stresses the generativity of such infrastructures. As Tilson et al. (2010, p.756) put it, they "render industries and products increasingly information based and reshape industrial organization and services as industries undergo comprehensive digitalization". Thus, the specific qualities of digital infrastructures ultimately enable them to reshape organizations. Kirsch &

Slaughter (2013) argue that digital infrastructures can support a transformation in the way science is conducted, while Lindgren et al. (2015) discuss how participating in a mobile ecosystem can question an organization's identity. Magnusson & Bygstad (2014) show how the installed base of IT can constrain future developments.

Some researchers ascribe roles to IT that go even beyond this. Eaton et al. (2015) show how digital infrastructures can be used as a means of control by the platform owner. Iannacci (2010) proposes a view of II as "grammar that underpins successful communication between and among disparate systems" (p. 46). Venters et al. (2014) employ a sociomaterial view, looking at the "dynamic interplay of generative material and social agencies, oriented to multiple dimensions of time" (p. 946). Finally, there is the notion of cultivation of the installed base (Grisot et al. 2014) and even the view of technological systems as "organisms with a life of their own" (Ciborra & Hanseth 1998, p.312).

2.4.5 Synthesis and areas for contribution

The concept of digital infrastructures provides a useful lens to look at information systems in organizations and beyond. It can help to conceptualize some genuinely new types of artefacts enabled through technologies like the Internet and mobile computing, but has also been used successfully in more traditional settings. It enables researchers to come up with new views of the role and impact of IT. It also seems to encourage an increasing amount of interpretive research based on qualitative data.

A central idea of digital infrastructures is that they are sociotechnical and their human and technical elements mutually shape the evolution of a digital infrastructure. The concept of evolution is also interesting, as it reflects on the way such systems grow over time. In particular, it points to the limits of rationality and control: As the systems may be held back by human and technical inertia, they are less amenable to change and control than managers coming from a traditional, positivist background may think. Similarly, the possible roles of IT become more varied and far-reaching in this view. The literature review has shown a number of examples of how it is not just seen as a tool, but a constitutive element of the context in which it operates. Papers about the future of Information Systems tend to express ideas that go even beyond this. Fichman et al. (2014) point out that the Internet as a

digital infrastructure has "accelerated the emergence of new technologies that enable transformations in how we live and work, how companies organize, and the structure of entire industries" (p. 329). Beath et al. (2013) acknowledge the "broad transformations that accompany pervasive digitalization of organizational life" (p. ii) and maintain that "IT has a primary role in shaping contemporary society" (bid.). It remains to be seen whether such views are justified. For now, it can be claimed that there are some interesting developments in the field of Information Systems research on digital infrastructures, but also areas for contribution.

Several areas for contributions were identified. While the concept of digital infrastructures is well established in recent Information Systems research (e.g. Tilson et al.'s paper has been quoted 113 times according to a recent database search), it has not yet been used much in areas usually researched by management-focussed Information Systems researchers, including organizational agility. This is surprising, given that its potential has been discussed for a while. E.g. Galliers (2007) argues that "the socio-technical concept of an information architecture or infrastructure has proven to be a useful building block" (p. 8-9) in "developing an integrated framework for IS strategizing" (p. 8). Instead, research on digital infrastructures is often focussed on the areas where the concept originated, like mobile communication (Sørensen et al. 2015) or the iOS ecosystem (Eaton et al. 2015) – despite Tilson et al.'s (2010) broad call for Information Systems research that aims at a "better understanding of the ways in which infrastructural change shapes IT governance, IS development, and promotes new effects across all levels of analysis (p. 757 f.)".

This call has been taken up and extended variously. Yoo (2013, p.228) argues that "management scholars need to account for the changes brought by digitalization, and build new theoretical frameworks to guide efforts to organize generative innovations." In Yoo's view, this could lead to "a more precise and nuanced understanding of the nature of digital technology that enables and constrains activities that produce generative innovations" (p. 231). This thesis aims to contribute to such an understanding by applying the concept of digital infrastructures to the area of organizational agility.

As Sørensen & Landau (2015) put it, research should look at the "complex inter-relationships between the granular and the infrastructural" (p. 167). Thus, the main area

for contribution here seems to be to apply the concept of digital infrastructures and its related methods to Information Systems research in more traditional, management focussed areas (like organizational agility in this case) to show how it can be fruitfully used there. This is particularly relevant in order to research information systems and organizations in a world that is rapidly changing due to digitalization and its consequences. Given its origins, the concept of digital infrastructures should be most useful to conceptualize these.

2.5 Summary and research question

2.5.1 Summary

While Information Systems research on organizational agility has made good progress in investigating the topic, some areas for contribution have been identified. These have been mainly defined around the way information systems are conceptualized. The traditional view of information systems as a tool that organizations can use unproblematically to achieve their goals is still fairly common. While the lack of variety in existing Information Systems research on organizational agility has been criticised (Salmela et al. 2015), the concept of agility has nevertheless been applied successfully in many contexts. This is illustrated by Salmela et al.'s literature review. Organizational agility is a subset of the broader area of Information Systems strategy research, so any findings should benefit this area as well. The area of organizational agility is well researched in the Information Systems literature. Nevertheless, areas for contribution were identified in the way agility is conceptualized, as well in the lack of research in the area that considers digitalization and its consequences.

This thesis argues that digitalization has led to significant shifts. These are reflected in the conceptualization of information systems in organizations as digital infrastructures. By acknowledging the grown, heterogeneous status of such infrastructures, as well as their socio-technical nature, researchers argue for a different way of engaging with them, which has been called, for example, cultivation. This reflects the different, broader and more varied ways the role of IT/ digital infrastructures is conceptualized. Research on digital infrastructures is growing and shows a welcome focus on qualitative data and interpretive analysis. The calls for broad research in this area are being heeded, but there are still large areas for contribution. By applying

the concept of digital infrastructures to organizational agility, and thus to the grown systems in a large company, this thesis aims to contribute to this emerging research tradition.

2.5.2 Outline of the approach taken here

From the discussion of the literature, an outline of how to conceptualize agility in organizations is emerging. This thesis will conceptualize agility as a performance and analyse it in a qualitative case study. The focus on performances connects this approach to the area of digital infrastructure research. This thesis takes up calls for broader research in this area by using the concept of digital infrastructures to conceptualize the emerging, open sociotechnical systems found in a large company. This will be elaborated in more detail in Chapter 3.

2.5.3 Research question

In summary, this thesis shares the view of agility as a performance that is constantly enacted by the members of an organization and thus cannot be measured. It proposes the concept of digital infrastructures as an alternative conceptualization for IT artefacts. The research question is "how can digital infrastructures support performances of agility in organizations?". The next chapter operationalizes this approach by defining a set of concepts and relationships that will be used as the basis for the case study.

3 Conceptual Framework

This chapter presents the conceptual framework that serves as the starting point for the case study. It defines the concepts that will be central for the analysis, discusses how they have been used in previous research and proposes relationships between them. The proposed framework serves as a less developed form of theory that will be tested and developed in the analysis of the case study findings in Chapter 6. From the conceptual framework, more specific research questions are derived.

3.1 Theory and the conceptual framework

It is important to appreciate the role of the conceptual framework and how it relates to theory generation. In this thesis, the conceptual framework draws on theories from prior research to define the theoretical concepts and the relationships between them that are proposed at the beginning of the case study. Having such a conceptual framework is essential for generalizing research results (Miles & Huberman 1994). Leshem & Trafford (2007, p.96) define the conceptual framework as a "less developed form of a theory" made up of "statements that link abstract concepts to empirical data" (following Rudestam & Newton 1992). Thus, the conceptual framework is essential in informing the research design.

Taking up the idea of the conceptual framework as a "less developed form of a theory" inevitably leads to the question what a theory is. There is some confusion around the term that stems from the fact that different concepts of 'theory' have different scopes. Some authors describe it in broad, abstract terms, e.g. as a "philosophical stance informing the methodology" (Crotty 1998, p.3). Crotty gives positivism and interpretivism as examples. Others use it in a narrower sense, similar to the term 'hypothesis'. For example, Silverman (2013, p.112) defines it as a "set of concepts used to define and/ or explain some phenomenon". The latter view is closer to the way the term is used in Information Systems research. Gregor (2006) uses the term 'theory' "to encompass what might be termed elsewhere conjectures, models, frameworks, or body of knowledge" (p. 614). McGrath (2013) distinguishes between explanations derived from grand theories, which she sees as too abstract and unsatisfactory, and explanations derived from empirical findings, which are hard to

consolidate. She argues for using middle range theories, which are moderately abstract, but can consolidate hypotheses and findings into wider theories. As middle range theories are the most common concept, and the most useful one, the term 'theory' is here meant to be synonymous with "middle range theory". In this thesis, the conceptual framework is seen as a "less developed form of a theory" that will be developed into an explanatory framework (Miles & Huberman 1994), thus contributing to the development of a middle range theory on agility and digital infrastructures.

Rigour in this thesis is supported by following the recommendations of Grover et al. (2008), who discuss how to develop rigorous forward thinking theory. They argue that authors should be clear about the motivation of the theory, state boundaries that limit its applicability, and define clear constructs and propositions. The idea of construct clarity is elaborated by Suddaby (2010, p. 347):

> Construct clarity involves the skillful use of language to persuasively create precise and parsimonious categorical distinctions between concepts. Second, construct clarity requires the author to delineate the scope conditions or contextual circumstances under which a construct will or will not apply. Third, not only must the theorist offer clear conceptual distinctions, but he or she must also show their semantic relationship to other related constructs. Finally, the theorist must demonstrate a degree of coherence or logical consistency of the construct in relation to the overall theoretical argument he or she is trying to make.

Mueller & Urbach (2013) extend such criteria into a general framework of seven quality criteria for theory evaluation, which also contains aspects like falsifiability, parsimony and generalizability. Together, such work shows that the Information Systems discipline is aware of the importance of generating good theory and there is an emerging consensus on the factors that make up such theories.

In summary, this chapter will define a conceptual framework consisting of concepts and relationships that will serve as the basis of the case study. In the analysis of the case study findings (Chapter 6), this will be developed into an explanatory framework that can contribute to a middle range theory on organizational agility. Chapter 4 will show how theory is developed in this thesis.

3.2 Background: Digitalization

3.2.1 Conceptualizing digitalization

As argued in the previous chapter, digitalization has led to important changes in organizations and their IT, which have not yet been fully acknowledged in Information Systems research on organizational agility. This section relates the term to digital convergence, defines it and reflects on how it affects IT in organizations.

As shown by Sambamurthy et al. (2003), digital convergence is an important driver of the current changes to IT in organizations. Initially, it was discussed around concepts like "mergers of core functionalities from the computer (calculation), the telephone (point-to-point connection), and the television (broadcasting)" (Sørensen 2011b, p. 470). Sørensen charts how usage of the term proceeded to shift to "the digitization of previous analogue communications and data, thereby allowing processing of data across previously separated carriers through open standards" (ibid.). This notion is developed into the broader concept of digitalization by Tilson et al. (2010), who define it as "a sociotechnical process of applying digitizing techniques to broader social and institutional contexts that render digital technologies infrastructural" (p. 749). This is distinguished from digitizing, which they see as merely "a technical process" (ibid.). As the term 'convergence' is fairly vague and not consistently used (Herzhoff 2009), this thesis will use the term 'digitalization' instead.

The above definition illustrates how digitalization increasingly affects a variety of areas of IT and business. Tilson et al. speak of "IT tearing down the old analog world and its associated social infrastructures" (p. 756). Nevertheless, research on digitalization is often focussed on the areas where the concept of digital convergence originated, e.g. digital artefacts (Kallinikos et al. 2012), digital media (Yoo 2013) or mobile ecosystems (Tilson et al. 2010). In contrast, some authors have used it also in the broader context of more traditional information systems in organizations (e.g. Hylving & Schultze 2013). There seems to be a case for applying the concept of digitalization more broadly in research on information systems.

3.2.2 Consequences of digitalization

Digitalization has led to a number of changes in the nature of information systems and the way they are conceptualized. Three of these are briefly introduced here,

namely modularity, generativity and the increased role of information in information systems and organizations.

As digitizing has separated information from a fixed medium for storage and transfer, more flexible, modular information systems are possible (Yoo et al. 2010). As per Yoo et al.'s (2010, p.727) definition,

> a modular architecture is characterized by its standardized interfaces between components. Modularity is a general characteristic of a complex system and refers to the degree to which a product can be decomposed into components that can be recombined.

Yoo et al. show how the digitalization of well-established analogue products has made new products possible that have significantly affected the competitive landscape, giving Amazon's Kindle and its ecosystem as an example. They theorize a layered modular architecture with loosely coupled elements integrating across boundaries like different companies or the physical vs. digital world. This illustrates how digital technology has become a part of business strategy. Consequently, Information Systems research can focus on supporting such net-enabled firms driven by modular architecture. Yoo et al. see this as evidence for the "profound changes in the industrial structure and competitive landscape" (p. 724) enabled by digitalization. While their focus is on product design, Yoo (2013) broadens the argument by pointing out how modularity "also affects the way firms are organized" (p. 229), as already demonstrated by Sanchez & Mahoney (1996). Specifically in the area of organizational agility research, Tiwana & Konsynski (2010) show how a modular architecture can help sustain alignment by increasing agility.

Modularity in turn increases generativity, defined as "a system's capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences" (Zittrain 2008, p.70). Eck et al. (2015) discuss the ways the term has been used in the Information Systems field. They argue that Zittrain intends to capture three aspects of generativity, namely "that technologies can drive individual and collective creativity" (p. 3), "that only through the participation of humans the generative capacity of a technology can be realized" (ibid.) and "that innovation happens on different layers – e.g., technology, content, and society – each of which may possess generative capacity on their own" (ibid.). Yoo (2013) argues that as a consequence

of digitalization, modularity is no longer sufficient as a framework for research and that innovations based on generativity are "distinctly different" (p. 228) from those based on modularity and better able to explain contemporary phenomena. His call for "a more precise and nuanced understanding of the nature of digital technology that enables and constrains activities that produce generative innovations" has been mentioned above as one of the starting points for the argument developed here.

Another consequence of digitalization proposed here is that the role of information in the context of information systems and organizations may also increase in significance as it gains relevance as an actor:

> information's involvement in socio-economic life is acquiring comprehensive dimensions that enlarge and deepen the impact it had on organizations during the second half of the 20th century (Kallinikos 2009, p.183 f.)

Information is conceptualized here as an element of digital infrastructures, and is introduced as such below (subsection 3.3.3). As discussed, digitalization and digital convergence lead to the separation of information from a fixed medium. For example, information that used to be stored on a CD may now exist in an MP3 file without any physical properties. This can be applied to other areas, as in the case of the separation of computing from a physical medium, as seen in some examples of cloud computing (Venters & Whitley 2012). It also enables a more modular architecture in which systems can be combined from standardized components like application program interfaces (APIs) or add-ons (Yoo et al. 2010). Some authors have speculated on the consequences of this. For example, Kallinikos et al. (2013) reflect on the properties of "digital artefacts", which they describe as "editable, interactive, reprogrammable, and distributable" (p. 357). In a similar vein, Mayer-Schönberger & Cukier (2013) look at datafication, the transformation of social action into online quantified data allowing real-time tracking and predictive analysis. In this context, the term 'big data' is often used. Mayer-Schönberger & Cukier (2013) define big data as "[t]he ability of society to harness information in novel ways to produce useful insights or goods and services of significant value" (p.2). Definitions in Information Systems research focus more on the aspect of data, e.g. "data that's too big, too fast or too hard for existing tools to process" (Clarke 2016, p.77). This is the definition followed in this thesis. Similar terms are applied by Constantiou & Kallinikos (2014) and Loebbecke & Picot (2015). Goes (2014, p.iii) adds that "[b]ig

data has been defined by the 4 V's: volume, velocity, variety, and veracity. The new paradigm comes by combining these dimensions." While Mayer-Schönberger & Cukier are very optimistic about datafication and the big data tools it enables, Kallinikos (2009) gives a more balanced view of the similar concept of informatization, "the computational logic by which reality is rendered as information" (p. 183).

3.2.3 Digitalization in the context of organizational agility

This thesis introduces the concepts of digitalization and digital infrastructures to Information Systems research on organizational agility in order to address some of the issues identified in the literature review. It argues that digitalization is relevant for researching the use and development of IT in large companies (defined by the British government (HM Revenue & Customs 2015) as companies with more than 500 employees and an annual turnover over €100 million). As shown in the literature review, digitalization has led to new ways to conceptualize information systems in organizations, notably the concept of digital infrastructures (Tilson et al. 2010). This thesis aims to show how this concept, originally used mainly to refer to present-day, web-enabled infrastructures like the Internet itself (Hanseth & Lyytinen 2010) or the iPad ecosystem (Tilson et al. 2010), can be used to describe the evolution of more traditional information systems in large organizations. This is illustrated using the case of Telco and the example of modifying historically grown infrastructures to increase agility.

The next section discusses how digital infrastructures are conceptualized here.

3.3 Conceptualizing IT as digital infrastructures

As argued in the literature review (Chapter 2), it is useful to conceptualize IT in large organizations as digital infrastructures. This thesis takes up this view and sees the concepts of "information systems" and "digital infrastructures" as different ways of looking at the IT in organizations. The view of IT as a digital infrastructure focuses on the particular qualities of infrastructures described in this section. This view has significant consequences on the conceptual framework and research design. Tilson et al. argue that such corporate infrastructures are affected by "new generative dynamics" (p. 751) due to qualities of digital infrastructures like loose couplings,

flexibility and the fact that they carry data, with its unique qualities (Kallinikos et al. 2012). This thesis shares this view, but uses the term ‘information’ instead of ‘data’, as explained below (3.3.3). As shown above, “digital infrastructures can be defined as shared, unbounded, heterogeneous, open, and evolving sociotechnical systems comprising an installed base of diverse information technology capabilities and their user, operations, and design communities” (Tilson et al. 2010, p.748 f.). Yet this is a very broad definition that leaves open questions like what is the difference between an information system and a digital infrastructure, or whether an entire organization can be seen as a digital infrastructure. To address such questions, this section will introduce the elements of digital infrastructures – here taken as the installed base of IT, the people using and designing them, and information – and the way they are conceptualized here. This is followed by a discussion of the qualities that separate infrastructures from information systems and a definition outlining how the term ‘digital infrastructures’ will be used in this thesis.

3.3.1 Installed base

Given the evolving, heterogeneous nature of digital infrastructures, a close focus on the legacy IT in organizations is required. Hanseth & Lyytinen (2010) call the socio-technical system at the heart of such infrastructures the “installed base” (following Star & Ruhleder 1996) and point out that it can both enable and constrain the evolution of infrastructures. Legacy IT is an established area of Information Systems research and practice (e.g. Jacobson et al. 1999). Willcocks et al. (2002) show the importance of infrastructure, seen as a socio-technical construct, in the delivery of operations. The concept of the evolving installed base takes up older threads of sociotechnical Information Systems research that argued for limits of rationality in the planning of information systems. Orlikowski (1996) speaks of situated change based on on-going practices of organizational actors.

In this thesis, IT will be conceptualized as the installed base of hardware and software within a digital infrastructure. The focus is on how this installed base has grown over time and how it evolves as people interacting with IT within the digital infrastructures try to adapt it to their needs. Due to this evolving nature of digital infrastructures, information systems are seen as less amenable to rational planning here than they would be in more traditional conceptualizations. Some research on

digital infrastructures has focussed successfully on this process of evolution and shown how it occurs in the socio-technical assemblage of digital infrastructures (e.g. Henfridsson & Bygstad 2013). Hylving & Schultze (2013) conceptualize the evolution of the instrument cluster in a car using the concept of infrastructure. Venters et al. (2014) research the tensions involved in the coordination of the emergence of a grid infrastructure. Given the capacity of technology to both enable or constrain change (Star & Ruhleder 1996; Hanseth & Lyytinen 2010), they can be seen both as success factors or obstacles, depending on the context. Thus, the case study will look for evidence of both.

3.3.2 People

The next key element of digital infrastructures are the people using and designing the IT within the digital infrastructure. An important characteristic of digital infrastructures, according to Tilson et al.'s (2010) definition, is that they are seen as sociotechnical. Thus, they are placed in the tradition of sociotechnical research outlined above. It is worth discussing some aspects of this that are relevant for how this research project will be conducted. The traditional sociotechnical view sees information systems as "man-machine systems" (Mumford 1995) and has a strong ethical drive, arguing for the importance of involving workers in the design of information systems and the idea of jointly optimizing social and technical systems. Land & Hirschheim (1983) argue that information systems failures can be avoided if information systems are seen as social rather than technical systems. This thesis will acknowledge these ideas by focussing on agility as a performance by users and developers within a digital infrastructure. The relevance of such a view of organizations has been argued elsewhere: E.g. Wenger (1998) conceptualizes them as constellations of communities of practice where people share knowledge and skills with each other. Recently, the term 'sociotechnical' seems to imply mainly that systems are seen to include people, but does not necessarily come with the emancipatory ideals of its original proponents (Winter et al. 2014; Sarker, Chatterjee, et al. 2013).

In this thesis, digital infrastructures are conceptualized as sociotechnical systems within an organization that serve a particular purpose. Thus, the users and developers within digital infrastructures have a key role in shaping their use and future development. It is, however, important to point out that organizations themselves should not

be conceptualized as digital infrastructures. Tilson et al. (2010) see digital infrastructures both as a "class of IT artifacts" (p. 748) and as "sociotechnical systems" (ibid.). Thus, it would be possible to see either a specific artefact (e.g. one system used by an organization that has evolved over time) or the sociotechnical assemblage of people in an organization and the portfolio of systems they use as infrastructural. On the one hand, it is useful to have such a broad definition of digital infrastructures as information systems are becoming more complex, e.g. being made up of systems in several companies or hosted centrally in the cloud. For example, Willcocks et al. (2013) have argued that companies are increasingly becoming "amorphous" as these boundaries are becoming blurry. On the other hand, the concept of digital infrastructures is only useful if there is a clear distinction of what it does and does not entail. It is argued here that, while it does not make sense to see Telco itself, or every IT artefact within it, as a digital infrastructure, it does make sense to conceptualize such sociotechnical systems within the company as digital infrastructures.

Finally, the concept of the organization has received a number of different definitions in the course of its history. March & Simon (1993) define organizations as "systems of coordinated action among individuals and groups whose preferences, information, interests, or knowledge differ" (p. 2). They argue for seeing decision making and the flow of information within organizations as the central construct, thus shifting the interest from the received view of organizations as hierarchies (Gulick & Urwick 1969). As the literature review has shown, such organizational processes and bureaucracy can affect agility. These can be seen as parts of a control system (Beniger 1986) designed to help the organization achieve its goals. Interestingly, as Beniger points out, the need to process information was what drove the development of the modern bureaucratic organization in the first place. Yates (1989) shows how such formal internal communication became the principal tool for managerial control as this control was exercised on the basis of flows of information and orders. She conceptualizes these as including "upward flows of communication [that] drew data and analyses up the hierarchy to serve as the basis for managerial control of finances, facilities, materials, and processes" (p. xvii).

This thesis acknowledges the role of users and developers by focusing on how they interact with, and shape, IT within the various digital infrastructures researched in

the case study. This is conceptualized in the notion of agility as a performance (by these users and developers), which will be introduced in the next section (3.4).

3.3.3 Information

As pointed out above, data and information play a key role in information systems post-digitalization. Thus, information is conceptualized as an element of digital infrastructures here. This idea goes back to Hanseth & Lyytinen (2010), who speak of "information infrastructures" and whose definition has been adapted by Tilson et al. (2010). While Tilson et al. do not focus on the role of data or information in digital infrastructures, they do point out that "data play a significantly different role in digital infrastructures than, say, a car in relation to transportation infrastructures" (p. 752) due to the unique properties of digital objects. They see this as one of the factors making digital infrastructures generative.

There is no consensus on how to define the terms 'data' and 'information'. As McKinney & Yoos (2010) show, "'[i]nformation' is poorly defined in the Information Systems research literature, and is almost always unspecified, a reflexive, all-purpose but indiscriminant solution to an unbounded variety of problems" (p. 329). Indeed, the most common use of the term they find, the token view, sees information as synonymous with data. Kettinger & Li (2010) find that "[d]ata (…) have been generally defined as the measure or description of objects or events" (p. 411) and "[i]nformation is usually defined as data processed into a form that has meaning to the user" (p. 412). This view of data as raw information is also the predominant view applied in recent Information Systems papers on data (e.g. Aaltonen & Tempini 2014; Constantiou & Kallinikos 2014). This thesis adopts a somewhat different view, based on that advocated by Checkland & Holwell (1998):

> there is a distinction to be made between the great mass of facts and the sub-set of them which we select for attention, those to which we pay heed. The obvious word for the mass of [f]acts is 'data' (p. 89).

Consequently, this thesis will see data as facts of the world. Whereas Checkland & Holwell coin the term 'capta' for the sub-set of data that is captured, this is called 'information' here[2]. This means that this thesis will talk about information (rather

[2] This view has been inspired by Neil Ingebrigtsen's blog, www.infogineering.net.

than data) stored and processed in digital infrastructures. Figure 2 illustrates the elements of digital infrastructures as conceptualized in this thesis.

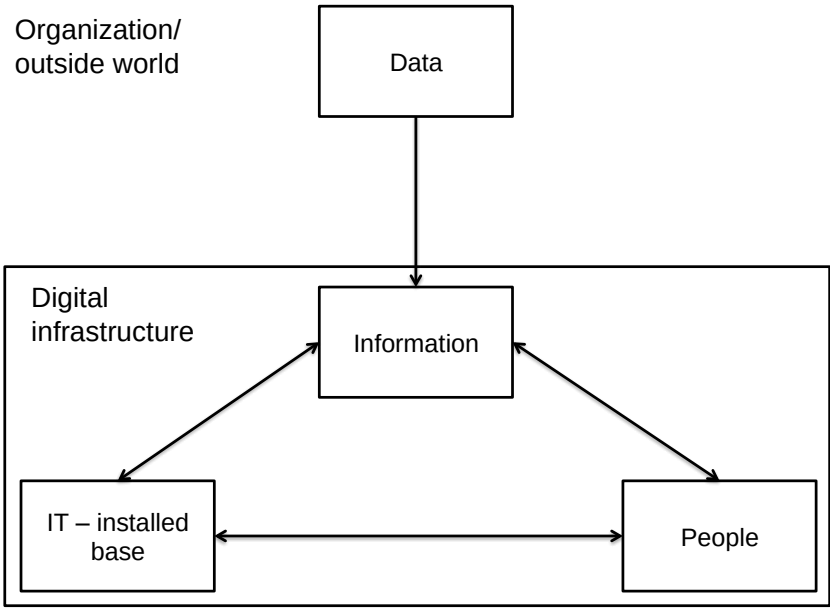

Figure 2 Elements of digital infrastructures

This view has several benefits: First, it enables a clear distinction between the concepts of data and information. It also affords seeing data as a (by-)product of business operations and information as the result of attempts by the organization to make use of data. The next chapter will illustrate how this aligns with the critical realist ontology underlying the research design in this thesis. The focus on the interactions between the elements of the digital infrastructure is also supported by the relational character of digital infrastructures. Based on these elements, the following interactions are proposed:

- Information enters the digital infrastructure when data from within the organization or from the outside world is captured and processed.
- Information is stored in IT. IT collects and processes information.
- IT supports the users, who in turn engage with and shape IT.
- Information informs the users, who in turn interact with it and modify it.

It is important to point out that these are just the main interactions and that the elements of digital infrastructures work together in each of them. For example, in the first interaction:

- Information enters the digital infrastructure when data from within the organization or from the outside world is captured and processed,

the processing and capturing of data is done by IT. Moreover, IT imposes limitations on this interaction, e.g. by speed or capacity restrictions or concerns for security and data protection. People have an important role here as well as they decide what data is relevant for them and trigger the capture of data. The role of information is very relevant throughout – e.g. in the interaction:

- IT supports the users, who in turn engage with and shape IT.

This interaction is fundamentally about the exchange of information. As mentioned before, this is an important part of managerial control (Yates 1989). More important in this study is the fact that the information processed by Telco employees can be seen as a digital object (Kallinikos et al. 2012) enabling generative uses. Table 6 gives an overview of how the different elements affect the proposed interactions.

Interaction	**Role of IT**	**Role of people**	**Role of information**
Information enters the DI when data from within the organization / the outside world is captured	Processing and capturing data	select what data is relevant for them – trigger capture	
	Limitations: e.g. speed/ security concerns		
Information is stored in IT. IT collects and processes information.	Limitations: e.g. speed/ security concerns	select what information is relevant for them – trigger storage	
IT supports the users, who in turn engage with and shape IT.			Interaction is about exchange of information – e.g. for management (Yates)
			also: digital object
Information informs the users, who in turn interact with it and modify it.	Enables exchange of information		
	Or limits it – capacity, security etc.	select what information is relevant – trigger exchange/ informing	

Table 6 Elements of digital infrastructures supporting interactions

3.3.4 Infrastructural qualities

So far, this chapter has discussed the elements of digital infrastructures and how to conceptualize them. This section will define the relevant qualities of infrastructures that this thesis will focus on.

One of the qualities that distinguish digital infrastructures from traditional conceptualizations of information systems is the fact that they are seen as historically grown and evolving. Similar notions have been employed in Information Systems research before, e.g. with Ciborra's (2000) notion of drift. As legacy systems have been used and incrementally developed over decades, this view of information systems as evolving appears to capture the reality in organizations well. It also reflects the reality of information systems use in organizations: As Mathiassen & Sorensen (2008) show, employees tend to build portfolios of services they use, rather than relying on a few monolithic systems. As the literature review has shown, researchers have successfully focused on the evolution of infrastructures (Bygstad 2010; Grisot et al. 2013) to explain how information systems in organizations are growing. This is reflected in concepts like the cultivation of the installed base (Grisot et al. 2014) or technological systems as "organisms with a life of their own" (Ciborra & Hanseth 1998, p.312). This thesis shares the view of digital infrastructures as growing and evolving and looks at how this can be influenced by people within the organization.

Star & Ruhleder (1996) also point out that infrastructure is normally invisible until it breaks down. This is a quality digital infrastructures share with the physical infrastructures of everyday life, like the electricity network. Thus, the case study will also look for evidence of whether people in the organization perceive their information systems as invisible, which would support conceptualizing them as infrastructural.

By conceptualizing agility as a performance, this study aims to contribute to a better understanding of the relational character of digital infrastructures. This is a central aspect of digital infrastructures as they are characterized by the relations between their elements. Star & Ruhleder (1996) argue that infrastructure is not a given capability, but "a fundamentally relational concept. It becomes infrastructure in relation to organized practices" (p. 4). Thus, it emerges in practice and becomes infrastructure only through such practices, as the same technology may or may not be seen as

infrastructural depending on the context. This implies a shift in focus from specific people or technologies to the organizational practices around them and, most importantly, the relationship between technology and such practices. Tilson et al. (2010) acknowledge the relational character of digital infrastructures, but do not discuss it in detail.

In summary, digital infrastructures are conceptualized here as sociotechnical systems within an organization that serve a particular purpose. They contain an installed base of IT, people (users and developers), and information. They are seen as relational, emerging from the relationship between technology and organizational practices and not amenable to direct managerial control. The focus on organizational practices, in this case, means investigating how people interact with evolving digital infrastructures, how they shape them, and how digital infrastructures affect organizational arrangements. From these reflections, it appears that there is no strict boundary to conceptually differentiate digital infrastructures from information systems. In other words, rather than see it as a different concept, it is possible to interpret existing information systems in organizations as digital infrastructures – as is done in this thesis. Such a view would focus on the qualities of digital infrastructures described here.

This thesis will focus on performances around organizational agility, which will be described next.

3.4 Organizational agility in digital infrastructures

This section discusses how organizational agility will be conceptualized in this thesis. In particular, it considers its nature as a performance, the specific performances of sensing and responding, and aspects enabling or constraining organizational agility.

3.4.1 Performance

This thesis argues that it makes sense to conceptualize agility as an organizational practice or performance within digital infrastructures that is both enabled and constrained by them. This subsection discusses how this conceptualization was devel-

oped. It will briefly discuss the literature on performances and practices before outlining how the terms are used here.

As pointed out in the literature review (2.3.6), Zheng et al.'s (2011) concept of agility as a performance is employed here as it has the potential to shift the focus of research on organizational agility to the practices in an organization. Moreover, it is interesting to see that there is a strong element of sensemaking (Weick 1995) within this collective agility as teams can develop a "collective attitude to deal with uncertainty and ambiguity" (Zheng et al. 2011, p.318), which will affect their performances. Thus, the concept of agility as a performance can help to overcome the issue of lack of variety in conceptualizing organizational agility, and seems to be a useful conceptualization for agility as it relates to complex processes of change in organizations. Furthermore, given the relational character of digital infrastructures discussed in the previous section, it appears that the notion of agility as a performance is a good nexus to connect the concepts of organizational agility and digital infrastructures.

This view of agility as a performance follows an established tradition of practice based Information Systems research shaped by Orlikowski (2000). This influential approach has to be seen in the context of the practice turn in the social sciences around the turn of the millennium. Schatzki et al. (2000) argue that the primary element of interest for social scientists should be practices rather than social structures or individuals, as this supports a move beyond problematic dualisms like subject vs. object. They see the social as "a field of embodied, materially interwoven practices centrally organized around shared practical understandings" (p. 3). In Knorr-Cetina's (2000, p.175) definition, "practices should be seen as recurrent processes governed by specifiable schemata of preferences and prescriptions." As technology is open to a wide variety of uses, it makes sense to conceptualize it as interpretively flexible (Orlikowski 1992) and focus on the specific performances around its use. Agency thus is not seen to lie with either the human actors or technology, but with practices, e.g. the way an information system is used in an organizational setting.

The terms 'practice' and 'performance' are not always clearly distinguished. Following Orlikowski & Scott (2008, p.460) "'performance' refers to the doing of some

activity (as when a physician 'performs' a medical examination, or a musician 'performs' in front of an audience)". Conversely, according to Reckwitz (2002, p.251), "[a] practice can be understood as the regular, skilful 'performance' of (human) bodies". While originally the term 'performance' seemed to have stronger connotations of how the self presents itself publicly (e.g. in Goffman's work), the terms now often seem to be used interchangeably: E.g. Zheng et al. (2011, p.305) define a performance as "an enactment within a context that can create, apply and sustain capabilities", while Orlikowski (2000, p.404) sees practices as "a process of enactment" (p. 404) of structures that shape the use of technology. Mol (2002) even argues for dropping the term 'performance' altogether in order to focus on this aspect of enactment without being drawn into the on-going discussions in the literature: "even if I have been using the term performance elsewhere in the past, I have carefully banned it from the present text. I use another verb instead, enact, for which I give no references, precisely because I would like you to read it in as fresh a way as possible. In practice, objects are enacted" (p. 41). This thesis will use the term 'performance' nevertheless, but relate it to this quality of being enacted rather than to any strict definition of the term in the literature, using it synonymously with 'practice' to refer to the interactions between the parts of digital infrastructures that serve to enact them.

Either way, from this conceptualization, it also follows that agility is not seen as a given quantity to be measured, but as a performance to be understood. This will be reflected in the research design, e.g. by not attempting to quantify agility.

3.4.2 Performances of sensing and responding in digital infrastructures

This thesis started out with the definition of organizational agility as "the ability of firms to sense environmental change and respond readily" (Overby et al. 2006, p.120). As agility is commonly discussed based on these activities, they are used to structure the conceptual framework here. Thus, in extension of Figure 2 (above), it is claimed that performances of sensing occur as data from within the organization or from the outside world is captured in the digital infrastructures. Performances of responding would then occur as the components of the digital infrastructure, i.e. information, IT and the people using it, interact. Figure 3 illustrates this.

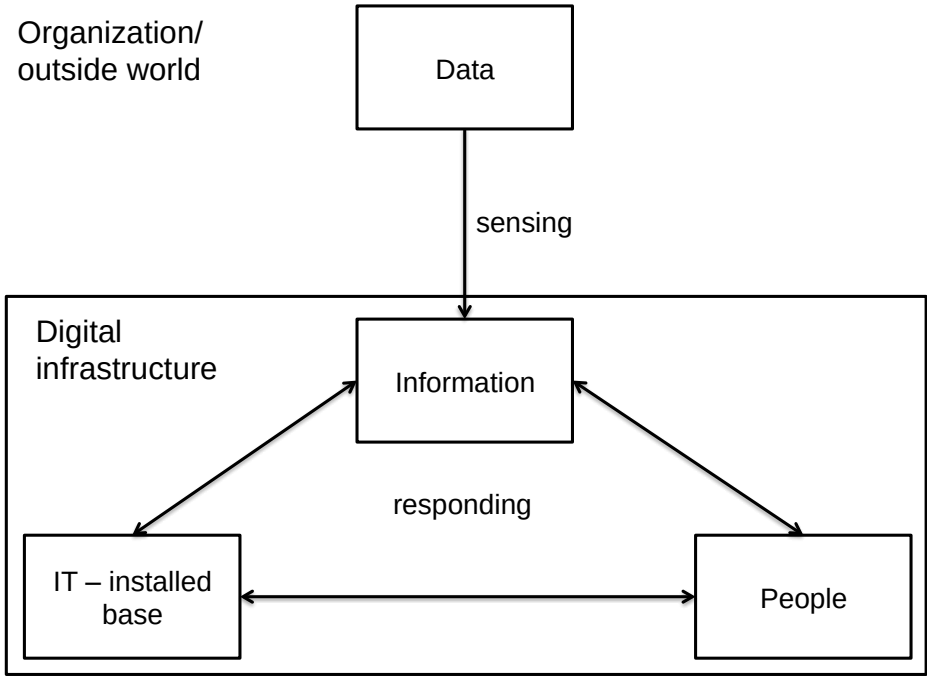

Figure 3 Sensing and responding in digital infrastructures

This case study will focus on responding rather than sensing, as its main interest lies in the role of digital infrastructures supporting such efforts. It also turned out that people within Telco see responding as more of an issue than sensing, as one interviewee pointed out:

> I think in terms of understanding what's going on, we're very good (…) I don't see any issues there. (…) In terms of actually understanding what's going on in the market and technical innovation that's going on, I think we are as good as anybody else at understanding the developments. (i4)

3.4.3 Obstacles/ success factors

As the research question relates to how digital infrastructures can support performances of agility, it is useful to consider the factors supporting organizational agility that have been identified before. These range from a straightforward reliance on IT capabilities (Chen et al. 2013; Lu & Ramamurthy 2011) to the way IT is managed and handled (Chakravarty et al. 2013; Huang et al. 2014) and on to more sophisticated concepts like an agile IT and process architecture (van Oosterhout et al. 2006), bricolage (Ciborra 1996; Zheng et al. 2011) or cultivating external relationships (Mathiassen & Vainio 2007). Tallon (2007) and Tallon & Pinsonneault (2011) also mention flexibility of the IT infrastructure as a success factor. Moreover, (Zheng et al. 2011) identify the "performance by knowledgeable actors who draw upon…

minimal structure, flexible planning, extensive communication and social bonding" (p. 326) as a success factor. Table 7 gives an overview.

Paper	**factors supporting agility**
Börjesson et al. 2006	guerilla tactic
Chakravarty et al. 2013	IT competencies, moderated by environmental dynamism
Chen et al. 2013	IT capability
Ciborra 1996	bricolage
Fink & Neumann 2007	IT personnel capabilities, mediated by IT infrastructure capabilities
Holmqvist & Pessi 2006	working continuously with scenario development, keeping implementation projects to a comprehensible size
Huang et al. 2014	construction of information processing network and implementation of organizational control
Kharabe & Lyytinen 2012	systems agility (supports organizational agility) ERP assimilation
Lu & Ramamurthy 2011	superior firm-wide IT capability
Lyytinen & Rose 2006	learning capabilities: exploration, exploitation
Mathiassen & Vainio 2007	e.g. cultivate external relationships, leverage component based architectures
Roberts & Grover 2012	knowledge creating synergy, process enhancing synergy
Sambamurthy et al. 2007	complementary relationships between IT and operational capabilities
Tallon & Pinsonneault 2011	alignment, IT infrastructure flexibility
Tallon 2007	management/ IT capabilities, flexible IT infrastructure
van Oosterhout et al. 2006	agile IT and process architecture
Zheng et al. 2011	loose coupling, culture of improvisation and bricolage, intelligence, trust and pragmatism/ performance by knowledgeable actors

Table 7 Factors supporting agility

These factors give some indications to the ways in which digital infrastructures may enable organizational agility. These relate either to the nature of the IT in digital infrastructures, or to its use. As the literature shows, agility can be supported by IT that is component based (Mathiassen & Vainio 2007), flexible (Tallon 2007) or loosely coupled (Zheng et al. 2011). Similar notions have been identified for the way information systems are used in organizations, especially around the concept of bricolage (Ciborra 1996; Zheng et al. 2011). This gives some points of reference as to how digital infrastructures could support organizational agility.

Given the dual nature of digital infrastructures as enabling and constraining change, this thesis will also consider how digital infrastructures can constrain organizational agility. This is not yet broadly covered in the literature. As the literature review has shown, some authors conceptualize IT as potentially enabling or hindering agility. van Oosterhout et al. (2006) discuss legacy systems as a disabler of agility, but also mention that organizational processes can hinder agility. Similarly, Lu & Ramamurthy (2011) find that "IT can also hinder and sometimes even impede organizational agility" (p. 931), citing "the limitations of inflexible legacy IT systems, rigid IT architectures, or complex nests of disparate technology silos" (p. 932) as an example. Kharabe & Lyytinen (2012) consider literature that argues that ERP assimilation has a net negative impact on organizational agility, but find no empirical evidence in their study. Either way, there is some evidence in the literature that information systems, and by extension, digital infrastructures, can both enable and constrain change in organizations. The case study will put a focus on obstacles and success factors of organizational agility in order to understand how people within Telco see agility.

3.4.4 Summary

Following the discussion on conceptualizing agility as a performance, a more specific definition can now be developed. Organizational agility is conceptualized here as a set of performances by the users and designers within a digital infrastructure in order to swiftly react to events in the outside world. These performances are based on the broadly used definition of enterprise agility by Overby et al. (2006), so they consist of

- sensing, in which data from within the organization or from the outside world is captured in the digital infrastructure, and
- responding, in which the components of the digital infrastructure, (information, IT and the people using it) interact with each other to adapt the digital infrastructure to the demands of the outside world.

Adapting Conboy's (2009) framework to the area of organizational agility, the following claims can be made:

- To be agile, a performance must contribute to one or more of the following:
    - creation of change
    - proaction in advance of change
    - reaction to change
    - learning from change
- To be agile, a performance must contribute to one or more of the following, and must not detract from any:
    - perceived economy
    - perceived quality
    - perceived simplicity

This implies that agility is a subjective perception. Thus, it cannot be measured. Instead, this thesis will focus on the perceptions of agility by the users and developers within a digital infrastructure. As users do comment on levels of agility, e.g. by comparing Telco to other companies, or the agility before and after a project was run, this thesis allows for different subjective levels of agility, based on employees' perceptions.

3.5 A model to explain organizational agility within DI

This section develops a theoretical model aimed at explaining organizational agility within digital infrastructures. This will lead to some more specific research questions, which will inform the research design, as discussed in the next chapter.

3.5.1 List of constructs

This section summarizes he most relevant concepts used in the conceptual framework and introduces definitions for them. The concepts and their definitions used here are summarized in Table 8.

Concept	Definition
Organizational agility	A set of performances by the users and designers within a digital infrastructure in order to swiftly react to events in the outside world. These consist of sensing, in which data from within the organization or from the outside world is captured in the DI, and responding, in which the components of the DI (information, IT and the people using it) interact with each other to adapt the DI to the demands of the outside world.
Digital infrastructures	Sociotechnical systems within an organization that serve a particular purpose. They contain an installed base of IT, people (users and developers), and information. DI are seen as relational, emerging from the relationship between technology and organizational practices and not amenable to direct managerial control. They are conceptualized as simultaneously enabling and constraining agility.
IT	IT in DI is conceptualized as the installed base of hardware and software. This evolves over time as people interacting with the DI shape it.
People	DI are seen as sociotechnical systems. Thus, the people using and developing IT within the DI have a key role in shaping its use and future development.
Information	Data captured and digitally stored in information systems

Table 8 Key theoretical concepts

3.5.2 Relationships between theoretical concepts

To develop its explanatory power, the conceptual framework needs to contain statements about the relationships between its concepts. The following relationships are proposed:

3.5.2.1 IT in large companies should be seen as digital infrastructures

This thesis argues that IT in large companies should be seen as digital infrastructures. The review of the literature on organizational agility has shown that there is potential for conceptualizations of information systems in organizations that go

beyond traditional notions like IT as a tool. While there is a paucity of research on digital infrastructures relating to large companies (despite calls for digital infrastructure research at broader levels), the concept lends itself to such research, as it contains the notion of a historically grown, heterogeneous infrastructure. Especially the concept of the installed base creating inertia, and the people in the digital infrastructure engaging with it, seems to fit well with existing research on legacy systems.

3.5.2.2 Organizational agility should be seen as a practice within digital infrastructures

As argued above, the concept of organizational agility is adapted in this thesis to better accommodate the reality in large companies. It is conceptualized here as an organizational practice within digital infrastructures. Thus, it reflects an organization's ability to influence the evolution of its digital infrastructures. This leads to a view of digital infrastructure change as evolution rather than planning, which stresses the focus on both the technology (Orlikowski & Iacono 2001) and the role of people engaging with it. It is in contrast with much research on agility that assumes a blank slate and the possibility to easily change things, led by the IT estate.

3.5.2.3 Digital infrastructures enable and constrain organizational agility

The literature review has shown a notion of a dual nature of technology, as it can both enable and constrain innovation in organizations. Hanseth & Lyytinen (2010, p. 4) argue that "the evolution of infrastructures is both enabled and constrained by the installed base". Magnusson & Bygstad (2014) propose the term 'technology debt' to illustrate these constraints. Such constraints can turn into resources (for example when deadlines push people to get work done), as Star & Ruhleder (1996) show. As shown in the literature review, Yoo (2013, p.231) argues that "digital technology […] enables and constrains activities that produce generative innovations". This notion is here extended to digital infrastructures, which are seen as simultaneously enabling and constraining agility. For example, their modularity and generativity may afford quick changes of the IT, whereas the growing installed base or the bureaucracy in a large organization may hinder them. This aligns well with the concept of bounded rationality that has been mentioned in some of the literature on digital infrastructures (Claggett & Berente 2012) and organizational agility (Mathiassen & Stage 1992; Roberts & Grover 2012). This idea goes back to Simon (1957),

who points out that approaches like statistical decision theory "require of rational man powers of prescience and capacities for computation resembling those we usually attribute to God" (p. 3) and argues for a different view of rationality in which "the nonrational and the rational are compounded in administrative man" (ibid.). Due to these limitations, organizations do not make optimal decisions, but satisfice by making good enough decisions. As an example, Mathiassen & Stage (1992) define uncertainty and complexity as the factors limiting rationality. Similarly, it is proposed here that the elements of digital infrastructures can constitute such boundaries for agility.

3.5.2.4 Focus on interactions between IT, information and people

Information is an important factor in conceptualizing both digital infrastructures and agility. It enables new activities of sensing and responding. It is explicitly seen as an element of digital infrastructures here. This enables a focus on the interactions between IT, information and people within the digital infrastructures. It also leads to a conceptualization of agility around activities involving information as sensing happens when data from within the organization or from the outside world is captured in the digital infrastructures, while responding refers to the interaction between the components of the digital infrastructures.

3.5.3 Summary

This chapter has defined the conceptual framework that will be employed to help answer the initial research question, "how can digital infrastructures support performances of agility in organizations?". Digital infrastructures are conceptualized here as sociotechnical systems within an organization that serve a particular purpose. They contain IT, seen as installed base, people (users and developers), and information. They are seen as relational, emerging from the relationship between technology and organizational practices and not amenable to direct managerial control. Agility is conceptualized as an organizational practice within digital infrastructures. Sensing and responding refers to activities around the flow of data into and within the digital infrastructures. Digital infrastructures simultaneously enable and constrain agility.

In elaborating its theoretical model, this thesis claims that IT in large companies should be seen as digital infrastructures, and organizational agility as a practice

within these infrastructures. Digital infrastructures are seen to both enable and constrain organizational agility. In order to understand these processes, a focus on the interactions between IT, information and people is proposed. Thus, the conceptual framework combines the notions of digital infrastructures and organizational agility as a performance and shows how this can be used to understand the effect of digital infrastructures on agility. It is summarized in Figure 4.

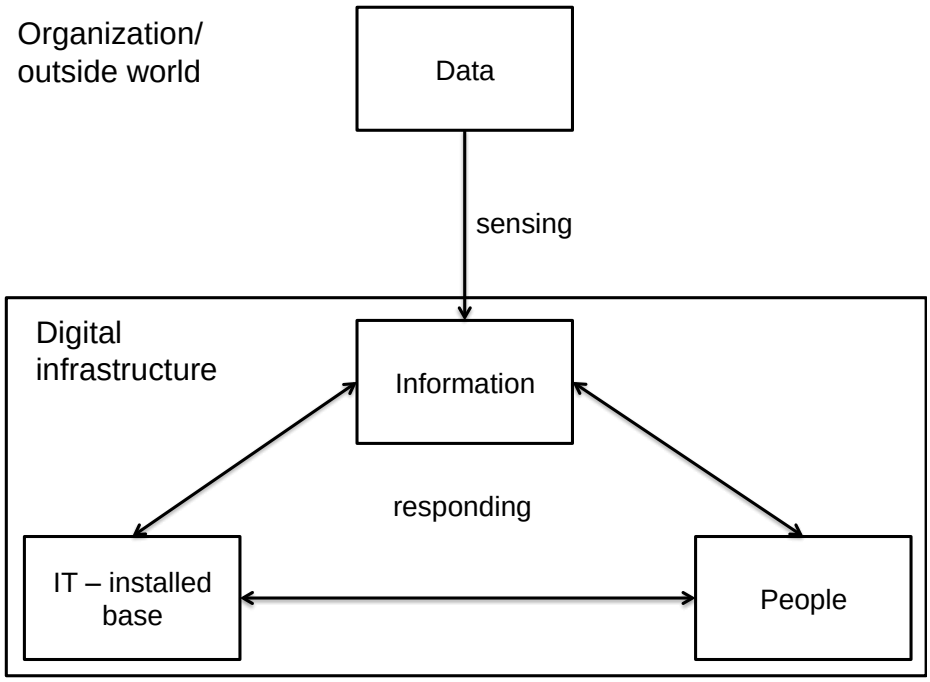

Figure 4 Conceptual framework

3.5.4 Research questions

Based on the conceptual framework, some more specific research questions can now be derived. These build upon the initial research question, "how can digital infrastructures support performances of agility in organizations?". As the conceptual framework proposes conceptualizing the IT estate in Telco as a digital infrastructure, the primary interest of this thesis lies in how this infrastructure affects their efforts at achieving agility. Given the dual nature of digital infrastructures, which can both enable or constrain change in organizations, the original research question is rephrased as

- **RQ1** How do digital infrastructures enable/ constrain performances of agility in organizations?

Moreover, the conceptual framework points to the importance of the interactions between the elements of a digital infrastructure (IT, people as users and developers, and information). Digital infrastructures are seen as sociotechnical systems (Tilson et al. 2010), so a focus on the role of people in such systems is crucial. Finally, the conceptual framework has argued for a focus on the role of information within digital infrastructures. Thus, the following two additional research questions are proposed:

- **RQ2** What is the role of people within digital infrastructures in performances of agility?
- **RQ3** What is the role of information within digital infrastructures in performances of agility?

The next chapter will outline a research design to address these questions.

4 Research Design

4.1 Introduction

4.1.1 Outline

In the previous chapter, a conceptual framework was developed that helped to develop some specific research questions. This chapter discusses the research design used to address these questions. Starting from the general question, "how can digital infrastructures support performances of agility in organizations?", the following specific questions were derived:

- **RQ1** How do digital infrastructures enable/ constrain performances of agility in organizations?
- **RQ2** What is the role of people within digital infrastructures in performances of agility?
- **RQ3** What is the role of information within digital infrastructures in performances of agility?

As the information systems at the heart of this case are conceptualized as digital infrastructures, the first question to consider is how to research these infrastructures. Tilson et al. (2010) point out the need to analyse "processes of embedding capabilities and standards in organizational practices, which enable new social behaviors". This should be done by capturing "the sociotechnical infrastructural dynamics of specific cases" (p. 753). On the other hand, they also mention the importance of generalizable findings to guide practitioners. Thus a research design is required that is able to capture specific processes in an organization, while at the same time supporting generalization beyond this case.

This chapter is structured as follows: This section proceeds by discussing questions of ontology and epistemology and how they affect the research design. In line with existing research on digital infrastructures, this thesis applies the case study methodology. The methodology is discussed and the context of the case study introduced in the next section (4.2). The following sections (4.3, 4.4) discuss choices of methods for data collection and analysis. These are followed by a section on theory building in Information Systems research in general, and in this thesis in particular

(4.5). The final section (4.6) summarizes the research design and discusses questions of research ethics and quality.

4.1.2 Epistemology and ontology

As the literature review has shown, questions of epistemology and ontology are essential for any research design. The dichotomy between the different research traditions in Information Systems is mainly due to different epistemologies – the prevailing quantitative research tradition tends to assume a positivist epistemology, whereas the qualitative tradition often takes an interpretivist view. Questions of how reality becomes known shape the research design. Any researcher takes an implicit position on these questions, so it makes sense to consciously consider the various traditions and their consequences for the research design.

The merits and shortcomings of the two main epistemological traditions in Information Systems research have been discussed in the literature review. This has shown some of the limitations of positivist research with regards to the research of agility in organizations. Firstly, the measuring of given facts may not be possible in ambiguous socio-technical settings. Instead, it can be argued that organizational agility is best understood as a complex socio-technical process that is enacted by a combination of people and technical elements. Arguably, these processes need to be understood rather than measured. An interpretivist research approach would address these concerns and fit well with the theoretical perspective on agility as a performance. Such an approach, however, would also raise other concerns. Criticism has focussed especially on the constructivist epistemology, which is seen as a useful corrective to positivism that nevertheless may have been taken too far: For example, Hacking (1999) gives a long list of concepts (from authorship to Zulu nationalism) that were claimed to be socially constructed at one time or other. He points out that the extreme view that everything is socially constructed is nevertheless quite rare. Kallinikos (2004) sees this view of pure constructivism as "misleading, unless qualified in elaborate ways" (p. 141) and points out that

> [t]he study of technology and its social impact cannot be exhausted at the very interface upon which humans encounter technology. Essential strips of reality are not observable or even describable at the level of contextual encounters (Searle 1995). Situated accounts of technology must be supplemented by wider reflection that captures the complex web of dependencies,

> interoperabilities, and institutional relations that sustain the embeddedness of technology in local contexts. (p. 142)

Mingers (2004b) makes a similar case about soft systems methodology, a key interpretivist method in Information Systems (Checkland 1981). He shows how Checkland "denies the ontological reality of 'systems' as actually existing in the world, instead reserving this concept for our *thinking about* the world" (p. 99, italics in original) and how this creates contradictions in dealing with a real world external to the observer. One point of criticism of interpretive approaches that is particularly pertinent for this study concerns the question of generalizability. Information Systems research in the interpretivist tradition often does not exhaust the possibilities for generalizing its results (Avgerou 2013). On the other hand, Information Systems as an applied discipline has a long standing tradition of producing research results that are relevant to practitioners (e.g. Mumford 1995; Checkland 1981). Obviously, the more generalizable research results are, the more applicable they would be for practitioners.

Critical realism can be seen as a reaction to some of the shortcomings of interpretivism. Mingers et al. (2013) point out its relevance for the field of Information Systems research:

> Critical realism offers exciting prospects in shifting attention toward the real problems that we face and their underlying causes, and away from a focus on data and methods of analysis. As such, it offers a robust framework for the use of a variety of methods in order to gain a better understanding of the meaning and significance of information systems in the contemporary world. (p. 795)

As Mingers (2004b, p.91) puts it, the goal of critical realism is to "re-establish a realist view of being in the ontological domain whilst accepting the relativism of knowledge as socially and historically conditioned in the epistemological domain". Such research looks at observations of events to account for mechanisms that cause these events. It sees reality as stratified into the domains of the real, the actual and the empirical, containing generative mechanisms, the events they generate and the subset of events that are experienced by humans respectively (see Figure 5, p. 84). On the other hand, it still accepts that social phenomena are socially constructed.

Critical realist research aims to go beyond description and come up with explanations. These often take the shape of causal mechanisms, which support generalizations beyond a specific case (Mingers 2004b). Mingers defines the real as "a complex interaction between dynamic, open, stratified systems" (p. 94), which give rise to generative mechanisms. As he points out, "[t]he interaction of these generative mechanisms, where one often counterbalances another, causes the presence or absence of actual events" (p. 94). Thus, a focus on both the mechanisms and their interactions is required. It is important to point out, however, that causality in critical realism is contingent rather than deterministic: "placing the same technology in a different context does not imply that the same mechanisms will be activated" (Klecun et al. 2014, p.151).

As the goal of this thesis is to define elements of an explanatory theory, it aims to identify mechanisms to explain how agility is enabled in Telco. This is done using a critical realist ontology, combined with an interpretivist epistemology, which allows for a focus on understanding the sociotechnical processes and activities of sense-making involved. The concept of mechanisms and the logic of inference used in this thesis will be discussed below (4.5.2). To ensure validity, the thesis follows received guidelines on conducting interpretivist research in general (e.g. Seale 1999) and for the field of Information Systems research specifically (Sarker, Xiao, et al. 2013). Figure 5 (based on Mingers 2004b) summarizes the stratified ontology of this thesis: Observed events in the domain of the empirical describe actual events, which are used to hypothesize generative mechanisms that have caused them. Mechanisms refer to the interactions of open systems in the domain of the real. These open systems include the organization and the digital infrastructures analysed in the case study. They cause events, which in turn can be observed. The performances of agility analysed in the case study are part of these events. Finally, generative mechanisms can be generalized and contribute to middle range theory.

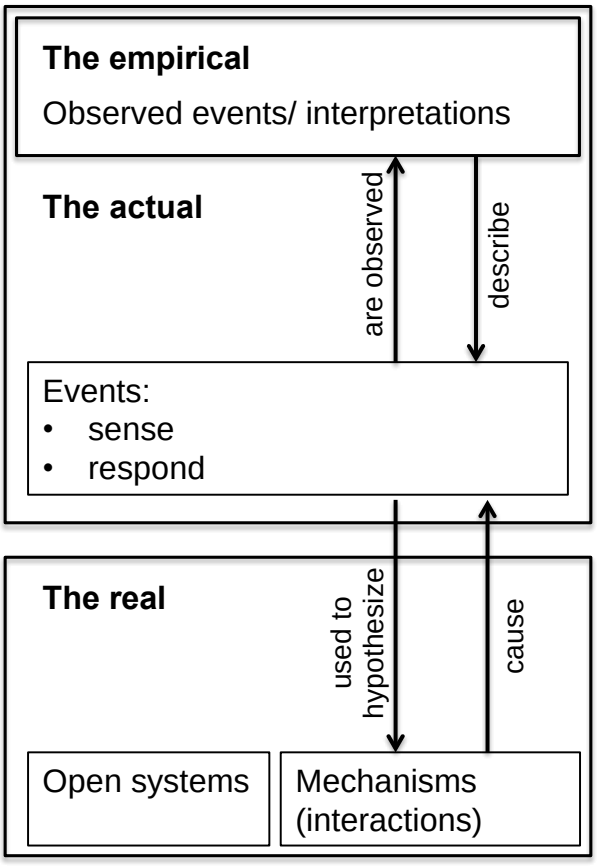

Figure 5 Critical realism: Stratified ontology

The next question to discuss is what consequences for the research design arise from this choice of ontology. In critical realist terms, the performances of agility are seen as events in the domain of the actual. The goal of this thesis is to explain such events by looking at how they are perceived by Telco employees in order to understand the mechanisms that are causing them. These may then explain how digital infrastructures can support the performance of agility. This thesis claims that, as an event, agility can be understood through the observations and interpretations by individuals in the domain of the empirical. It is contingently caused by generative mechanisms in the domain of the real. Likewise, it can be posited that data, as facts of the world, is located in the domain of the actual, whereas information, as processed data, is located in the domain of the empirical, where it represents events. Thus, capturing data and storing it in information systems also transfers it to the domain of the empirical, opening it up to analysis.

Consequently, the ontology of critical realism has been selected for this thesis as it was seen as a good way to avoid the issues of positivism and constructivism dis-

cussed in the literature review, as well as to identify generative mechanisms that provide explanatory potential, ideally beyond the case study. Critical realism has proved useful in this thesis. The stratified ontology has provided a useful lens to look at the information systems in this case. As the domain of the real is based on open systems and the interactions between them, it was easy to relate this to digital infrastructures (which are open systems following Tilson et al's definition) and the interactions between them. Moreover, this focus on interactions also fits well with the focus on performances in this thesis. Thus, it appears that critical realism can be useful for researchers interested in researching the effects of digitalization and coming up with explanatory middle range theories.

The methodology most commonly used in critical realist research is the case study approach. This will be discussed next.

4.2 Case Study

Following the tradition of critical realist research, a case study was conducted to address the research question. This section discusses this choice of methodology as well as important design aspects of the case study.

4.2.1 Choice of methodology

Case studies are a broadly accepted methodology for qualitative research. Richardson et al. (2014) summarize the benefits of the case study approach:

> The case study method provides an opportunity to explore significant phenomena in a unique context in which existing theory only provides a partial explanation and descriptive data can be especially revelatory (…). Case studies that explore exemplary organizations take advantage of rich, yet rare, instances of a phenomenon that has not previously received contextually sensitive research attention. (p. 6)

Yin (2009) defines the case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context" (p. 18) and points out that case studies are most appropriate for "how" or "why" questions. He shows that they can produce useful, valid results if conducted with sufficient rigour. There is a long history in the Information Systems field of case studies whose authors have immersed themselves in the organization to be researched and based their research

on the rich narratives drawn from this (e.g. Markus 1983; Walsham 1993; Mumford 1995; Beynon-Davies et al. 2000; Ciborra 2004). While the case study as a methodology is generally well regarded, rigour remains a concern. In the field of Information Systems research, Dubé & Paré (2003) find that, while the methodology is broadly used in the field's top journals, "fewer than half (42 percent) of the case study articles specified clear research questions" (p. 607) and the same percentage "did not elucidate how data was collected" (p. 612). Although their study was focused on positivist research only, it is a useful reminder to strive for rigour in research design.

As the goal of this thesis is to explain how agility is supported by digital infrastructures, an explanatory case study has been conducted. Yin (2009) recommends that such studies begin by constructing a preliminary theory, which can serve as a "sufficient blueprint for your study" (p. 36). This is what the conceptual framework (Chapter 3) does in this thesis. To generalize findings beyond the original case study, the logic of analytic generalization, "in which previously developed theory is used as a template with which to compare the empirical results of the case study" (p. 38), can be employed.

Analytic generalization illustrates what Yin calls "level two inference" (p. 39). Research conducted using statistical methods would first generalize from the sample of a study to the population it was taken from (level 1 inference) and then draw further inferences (e.g. support or disprove theories) based on the characteristics of this population (level two inference). Case study research, on the other hand, is only concerned with level two inferences. As illustrated above, analytic generalization can lead to theories that are relevant beyond the single case study. This is important as it usually would not be possible to arrive at similar results using statistical techniques – Yin points out that "your cases are not 'sampling units' and should not be chosen for this reason" (p. 38). Thus, it seems that criticism of the case study methodology aimed at its lack of generalizability compared to statistical methods is missing the point, as its own logic of inference means that, if they are well constructed, case studies can be as valid as other research methodologies.

There has been some debate on the use of case studies within critical realism. It could be argued that the stratified view of reality in critical realism poses particular challenges to conducting case studies. Whereas the events of interest in a case are

located in the domain of the actual, the mechanisms causing them are located in the domain of the real. However, the only domain accessible for research is that of the empirical (e.g. through interviews). The way around this is the process of retroduction, where researchers "take some unexplained phenomenon and propose hypothetical mechanisms that, if they existed, would generate or cause that which is to be explained" (Mingers 2004b). However, this is not fundamentally different in interpretivist research, as it has to deduce from the observation of human behaviour as well. Tsang (2014) points out that case study researchers can benefit from a critical realist view, as this can help them to achieve more generalizable results: "Case studies provide useful information regarding how the postulated mechanisms operate under a set of contingent conditions by striving to understand empirical events in their rich context" (p. 180 f.). Gerring (2004) even maintains that case studies "enjoy a comparative advantage" (p. 348) when researching causal mechanisms: "Case studies, if well constructed, allow one to peer into the box of causality to the intermediate causes lying between some cause and its purported effect" (ibid.). This was demonstrated recently as a number of case studies using critical realism were published in a special issue of the *MIS Quarterly* journal (Mingers et al. 2013). Wynn & Williams (2012) show that "several [critical realist] researchers have identified the case study method as the best approach to explore the interaction of structure, events, actions, and context to identify and explicate causal mechanisms" (p. 795) and develop principles on how to conduct case studies following a critical realist ontology. As shown below, this thesis follows these guidelines in order to address the research questions. Specifically, the process of retroduction in order to identify generative mechanisms is illustrated in Chapter 6.

4.2.2 Case selection

This study was conducted as a single-case case study. An embedded case study design (Yin 2009) is employed, as the case consists of three embedded units of analysis within Telco. This section introduces the context for the case study, discusses the choice of Telco as the case to be researched, and introduces the units of analysis.

The case study is looking at Telco (a pseudonym), a large British company in the telecommunications sector. Senior managers of Telco have expressed a desire for the

company to be more agile as they felt the company was having difficulties in keeping up with its competitors in some areas. Telco is a major participant in several competitive markets, so its management is very interested in the concept of organizational agility. In its annual report for 2013, the company announced its plan "to drive down cost and become a more agile and competitive organisation" in order to "take advantage of opportunities in the managed networked IT services market more quickly" (d4).

The choice of a large, traditional company like Telco as a case to research operational agility may seem paradoxical. However, Telco serves as a typical case (Yin 2009) as it represents many large organizations that have grown historically and are now facing the issue of having to compete against smaller, younger competitors, who their employees often see as being more agile. Telco sees agility as an important strategic goal and presents a good opportunity to research the role of digital infrastructures in organizational agility as its IT estate has grown over decades. Finally, the researcher had a good opportunity to gain access to the company and reach out to employees for interviews and observations. The case study started with an exploratory phase in order to gain an overview of the case, then focussed on some specific projects that demonstrated successful changes to Telco's agility.

After the exploratory phase of the case study, the choice of areas to be researched followed recommendations by interviewees. Thus, three projects were identified that were mentioned by Telco employees as examples in which the company had successfully managed to increase agility. These projects, which make up the three embedded units of analysis, are here called Analytics, OfferMaker and SalesTool. They will be presented in the next chapter.

4.2.3 Ethics

Ethical considerations are an essential aspect of any research design. Tracy (2010) counts them among her "eight 'Big-Tent' criteria for excellent qualitative research". Research needs to adhere to strict ethical standards to protect its subjects and to conform to academic standards. To ensure this, the research ethics review checklist published by the London School of Economics and Political Science (LSE) was followed, which LSE mandates "should be completed for every research project that involves human participants, personal, medical or otherwise sensitive data or metho-

dologically controversial approaches" (LSE 2014). This incorporates the requirements as prescribed in the ESRC research ethics framework. The areas of concern identified were 'confidentiality' and 'dissemination'. To address these concerns, and especially Telco's need for confidentiality, the LSE has signed a non-disclosure agreement with Telco. Moreover, a one page summary of the research project was disseminated to potential participants along with an informed consent form. Interviewees were asked to sign this prior to the interview. This gave some background on the study and pointed out the relevance of interviews as a source of data. It also educated them on their rights, e.g. to withdraw participation at a later time:

> Interview transcripts will not contain any personally identifiable information. Personal information will be treated as strictly confidential and will not be made publicly available or given to any other person. Information generated by the study may be published, but no details will be published from which participants could be identified. Moreover, any publications will be reviewed by [Telco] for any disclosure of confidential data.
>
> (from the interviewee consent form)

To protect this information in practice, interviews were transcribed in full and stored only locally on the researcher's computer. They were then anonymized and stored on shared folders on Dropbox. These have a high degree of data protection (Dropbox 2014) and could only be accessed by the researcher and his supervisor. The files were then used for analysis in Atlas.ti and for quotes in Word documents. In order to protect the confidentiality of Telco's information, the company and some tools have been pseudonymized in this and future publications. Moreover, any publications will go through Telco for approval.

It was interesting to note that, instead of impeding the data collection, these provisions actually helped it. Several interviewees commented on how they would not have felt comfortable participating without a non-disclosure agreement in place. The ways of protecting their anonymity, as outlined here, further supported this.

4.2.4 Case study design

The case study design follows the recommendations by Yin (2009), who points out the importance of developing a preliminary theory to guide the data collection. This corresponds to the conceptual framework here, which serves the same purpose. It is

used as the basis for explanation building, named by Yin as a technique to maintain quality. Specifically, explanation building and the use of a preliminary theory will serve to increase internal and external validity in this thesis. This will be discussed in the context of qualitative research design in the section on data analysis (4.4). The fact that the case study consists of several units of analysis and employs different sources of evidence (interviews, observation, documents) increases construct validity. This is further supported by a clear chain of evidence, as shown in Figure 6 (following Yin 2009, p.123).

Yin	**This thesis**
Case study report	Chapter 6 - Analysis
	↕
Case study database	Raw data (e.g. interview transcripts) stored in Atlas.ti
	↕
Citations to specific evidentiary sources in the case study database	Chapter 5 - quotes from Atlas.ti
	↕
Case study protocol (linking questions to protocol topic)	Chapter 4 - e.g. field procedures, case study questions
	↕
Case study questions	Research questions (from Chapter 3) and how they are turned into case study questionnaire (see Appendix B)

Figure 6 Chain of evidence

In this case study, conclusions in the analysis chapter (Chapter 6, equivalent to the Case Study Report in Figure 6) are based on findings from the case study, presented in Chapter 5 (equivalent to the Case Study Database in Figure 6). These draw on the full transcripts of interviews and observation sessions as the specific evidentiary sources, which in turn are motivated by the case study protocol, which contains the questions asked of interviewees. These are drawn from the case study questions, the research questions developed in Chapter 3 and how they are turned into the case study questionnaire. This chain of evidence enables other researchers to follow up on

the logic of an argument by consulting the initial sources of data. Finally, the case study protocol and case study database help to increase reliability.

Beyond these general guidelines, the specific recommendations by Wynn & Williams (2012) for conducting case studies following a critical realist ontology were followed. Table 9 shows how they have affected the research design. Retroduction is at the centre of the data analysis. Different units of analysis and sources of data were used, and for empirical corroboration, some of the proposed findings were discussed at a workshop with two Telco employees. This is discussed below (4.4). Moreover, an early version of the findings was presented at a Thought Leadership event with Telco that was attended by about 100 global staff live and via video conference.

Principle	**In this study**
Explication of Events	Focus on events and describe them as well as their structure and context (Chapter 5).
Explication of Structure and Context	
Retroduction	Hypothesize generative mechanisms that led to these events (Chapter 6).
Empirical Corroboration	Present and discuss the mechanisms with Telco.
Triangulation & Multimethods	Use of three units of analysis and different data sources

Table 9 Case Study principles (Wynn & Williams)

The case study will focus on events as reported by select employees of Telco. The analysis (Chapter 6) will seek to explain these by identifying generative mechanisms that can support these events. The principles mentioned by Wynn & Williams that go beyond Yin's account of the case study include retroduction and empirical corroboration. Retroduction ("identify powers that may have generated the events", p. 796) will be further discussed in the data analysis section (4.4).

4.3 Data collection

This section discusses the methods of data collection used in the case study, interviews, observations and documents.

4.3.1 Interviews

Interviews were chosen as the main method of data collection. As has been shown in the literature review, interpretivist research looks at the performances by human actors as they engage with an information system. As the conceptualization of agility used in this thesis looks for qualities like "perceived economy" or "perceived simplicity" (following Conboy 2009), these can be explored by talking to the actors involved and asking about their perceptions. Thus, data was collected through semi-structured, qualitative interviews with employees within Telco. Interviews were typically 45 minutes to 1 hour in length. All interviews were transcribed by the researcher with the help of a transcription software (f5transkript) before they were coded using ATLAS.ti. 40 interviews were conducted (see Appendix A for details – referenced below in the form i*x*).

Like all methods of qualitative data collection, interviews involve a degree of subjectivism in their interpretation (Holstein & Gubrium 1997). Gaskell (2000) points out the limitations of interviews as a data collection method, which amount to the fact that all information is gained through the eyes of the interviewees, so it may be limited or biased. Even the process of transcribing interview recordings can be seen as an act of construction and sense making (Hammersley 2010). Kvale & Brinkmann (2008, p. 53) sum up the unique features of interviews: "Interview knowledge is produced, relational, conversational, contextual, linguistic, narrative, and pragmatic." Thus, the interviewer plays a key role in constructing meaning as well, for example by choosing specific questions, or by writing up the interview findings in a certain way. This fits with the interpretivist epistemology of this study as well as the stratified ontology of critical realism, in which interviews would be seen as empirical data that is subject to people's interpretations. Thus, their subjective nature is acknowledged in this study.

Interviews can still be a useful way of data collection if researchers reflect on these limitations. By following established standards and guidelines, this thesis aims to avoid these shortfalls and produce results that are of high quality and validity. It has been pointed out, however, that interviews are in no way objective and should not be seen as a method to reveal an inherent truth hidden in a case to be studied. Indeed,

researchers should embrace the active character of the interview, as (Holstein & Gubrium 1997) point out:

> we suggest that researchers take a more active perspective, begin to acknowledge, and capitalize upon, interviewers' and respondents' constitutive contribution to the production of interview data. This means consciously and conscientiously attending to the interview process and its product in ways that are more sensitive to the social construction of knowledge. (p. 114)

This study acknowledges the produced and contextual character of interviews by adopting an interpretivist epistemology. Rigour is ensured by following the recommendations for qualitative interviewing given by Myers & Newman (2007):

- Situating the researcher as actor: Potential interviewees received a document introducing the researcher and outlining the research project. This was also discussed briefly at the start of each interview.
- Minimise social dissonance: Due to the researcher's experience working in a high-tech environment, he was reasonably able to blend in with the more tech-savvy interviewees. He made sure to repeat some of the jargon they used, and sometimes mentioned experiences from his own work history. Moreover, the confidentiality of any information shared was stressed in line with the non-disclosure agreement signed with Telco and LSE's ethical guidelines.
- Represent various "voices": People from various departments and with different levels of seniority were interviewed – from call centre workers to C-level executives.

4.3.2 Other data sources

Beside the interviews, some other types of data were used as well. Ten observation sessions were conducted with various employees in Telco call centres using some of the tools described in the case study (see Table 10 for an overview). These gave valuable insights into the ways Telco employees use their tools and structure their workflows, and gave the researcher the opportunity to observe some of the tools described in the case study, as well as the way people interacted with them. A small number of documents deemed relevant by interviewees were also considered – these

included screenshots of relevant tools as well as some emails. Observations and documents are referenced below in the form o*x* or d*x*.

Date, duration	Location	Observations
11 December 2014, one day	Accrington call centre	o1-o2
	Warrington call centre	o3-o5
18 February 2015, half day	Canterbury call centre	o6-o7
04 March 2015, one day	Newcastle call centre	o8- o10

Table 10 Site visits and observations

Some of the same points of criticism that have been discussed with regards to interviews can also be made about these methods. Clifford & Marcus (1986) call ethnographies "fictions" (p. 6) and point out that in ethnography, a neutral account is not possible as by writing, researchers create reality. Yet the benefit of participant observation is precisely that it allows the researcher to become part of this process of meaning-making: By immersing in the scene to be researched, they can understand the actors' points of view and see how these are socially constructed. Documents are more concrete than interviews or participant observation in that it is usually clear what has been said, and by whom. Nevertheless, even texts can be ambiguous, as evidenced by the tradition of hermeneutics from biblical texts to modern literature (Myers 2004). Moreover, as with the other data considered here, documents can be seen to construct the reality of their author, so they should not be taken at face value uncritically. This is again ensured by the interpretivist epistemology in this thesis.

4.3.3 Questions to ask

Despite these limitations, these methods should yield a good understanding of the generative mechanisms at work at Telco. Potential questions to ask of the case study, based on the conceptual framework, include:

- What is Telco employees' idea of organizational agility?
- How to they seek to achieve it?
- What obstacles do they perceive?
- What are the processes of sensing and responding involved?
- What is the role of information systems in these processes? What sort of information systems are used?

Additionally, the research agreement document with Telco contained a number of questions to direct the study:

- "Developments would need to be made in an agile way, potentially superceding other planned developments – but how are these prioritised?"
- "What processes are currently in place and how (or why) could they be circumvented to allow for innovation?"
- "What are the opposing forces at play which may affect an individual's ability or willingness to circumvent a process?"

From these questions, and their scope, it was concluded that the case study should begin with an exploratory phase in order to gain an overview of the case before it could focus on more specific aspects of the case in a second phase. These questions were then translated into a questionnaire, which served as the basis for the interviews.

The initial questionnaire was based on key concepts from the conceptual framework (see Appendix B). It was adapted during interviews according to the way the interview developed. As the case study progressed, interviews became less structured, as they increasingly focussed on aspects of the specific projects the interviewee was working on. Having this questionnaire, however, ensured that no important questions were omitted and that procedures like sharing information about privacy and data protection were observed.

4.4 Data Analysis

So far, the fundamentals of the research design including epistemology, ontology and methodology have been discussed, as well as what data was collected in the case study. The next question to address is how the case study data was analysed.

4.4.1 Introduction

Given the interpretivist nature of interview data, a method of data analysis is required that reflects on the subjectivity of such data while at the same time producing rigorous results. A variety of methods have been developed to analyse textual data like interview transcripts. This thesis follows the general method of analysing qualitative data outlined by Miles & Huberman (1994), enhanced by some elements

focussed on thematic analysis. Miles & Huberman define three flows of activity that make up the process of qualitative analysis:

- Data reduction
- Data displays
- Conclusion drawing/ verification

More specifically, these can be seen as rising levels of abstraction as the analysis progresses, as they show in Figure 7 (Miles & Huberman 1994, p. 92, following Carney (1990)). Under the labels of "summarizing and packaging the data", "re-packaging and aggregating the data" and "developing and testing propositions to construct an explanatory framework", these were used to structure the data analysis. These stages are discussed in the following subsections.

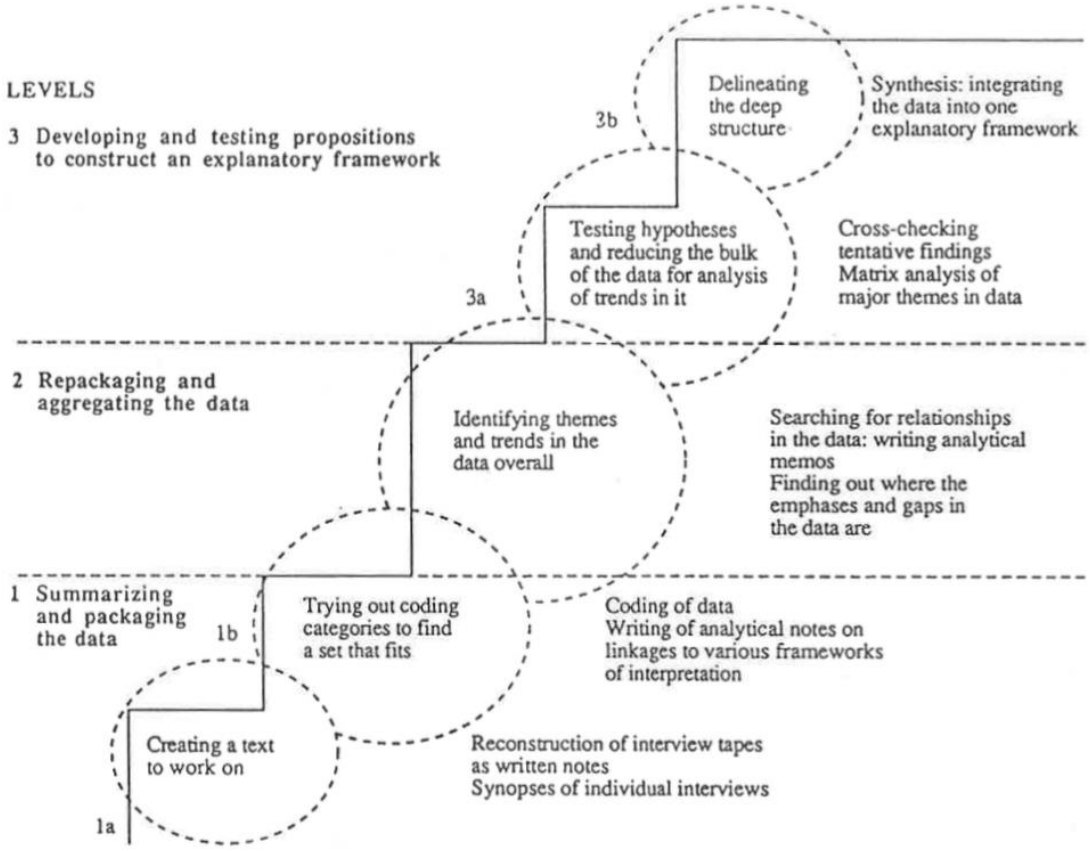

Figure 7 Ladder of analytical abstraction

4.4.2 Summarizing and packaging the data

The first stage of the analysis was about preparing data for the analysis process. Before analysis, interviews were transcribed by the author. Moreover, a short "Interview Summaries" document was created to collect the main points from each inter-

view. A concise description of the case findings was developed to summarize events. This served as the basis for Chapter 5 of this thesis.

This was followed by the development of the code book. The initial code book was informed by prior research and the conceptual framework. The focus was on events around the activities of sensing and responding that were reported by interviewees. It was extended by findings from the first few interviews. The initial coding scheme also contained the concept of "IT as an infrastructure", with categories for the qualities of "grown", "amorphous" and "invisible", which had emerged from the discussion of previous literature in Chapters 2 and 3. Additional themes covered aspects of IT and management and perceptions of agility (see Table 11).

Themes	**Category**	**Sub-category**	**Description**
Agility events	Sensing	Traditional	sense environmental change - traditional methods
		New	sense environmental change - new methods
	Responding	Traditional	respond readily to environmental change - new methods
		New	respond readily to environmental change
IT / management	Existing systems	1st generation	generations of CRM tools in Telco
		2nd generation	
		3rd generation	
	Planning		rational planning of future IS
	Evolution		IS transforming over time
	Adapting		users re-shaping IS as needed
Perceptions of Agility	obstacles		factors keeping Telco from being more agile
	success factors		factors making Telco more agile
	agility as a performance		evidence of agility seen as performance
IT as infrastructure	Grown		IT infrastructure historically grown, heterogeneous
	Amorphous		Boundaries of IT systems becoming blurred
	Invisible		As systems turn into infrastructures, they become invisible/ are taken for granted

Table 11 Initial coding scheme

Interview transcripts were then coded using the Atlas.ti software. The decision was made to use Atlas.ti to support data analysis because such CAQDAS (Computer Assisted Qualitative Data AnalysiS) software is seen as helpful in managing a large body of data and a growing number of codes. It also affords more flexibility than manual coding (see e.g. Friese 2014). However, the usefulness of such software is disputed:

> Computer programs are both technical tools and rhetorical devices. The rhetorical presence of CAQDAS is exploited both by software designers in their marketing and by users in their strategic presentations to grant-making bodies, readers of research reports, and the like. Many features of the software serve as symbols to address the subcultural preoccupations of different groupings within the research community. In particular, CAQDAS programs address the quantitative/qualitative divide by presenting features appealing to scientific conceptions of rigor on the one hand and promising theoretical sophistication on the other. (Seale 2002, p.652)

Nevertheless, it was felt that the benefits outweigh these issues and a reflective use of CAQDAS software was warranted. Throughout the project, the software turned out to be useful for storing and coding the interview data but, as conjectured by Seale, its more advanced features were not used.

4.4.3 Repackaging and aggregating the data

The second stage of analysis involved repackaging and aggregating the data. According to Miles & Huberman (1994), this is done by identifying themes and trends in the data. Codes were summarized and merged in a second round of coding, before more conceptual codes were developed. After the first round of coding, there were 550 codes, which were reduced to 295 by cleaning up and merging. In parallel, higher level ideas were developed in memos, which served as the starting point for the analysis. The aim of the second round of coding was to synthesize codes and to move them from a descriptive to a conceptual level (Friese 2014). Thus, more complex themes emerged. These focused on:

- Obstacles and success factors for agility mentioned by interviewees
- A detailed description of the cases, along with benefits and limitations
- An overview of the historical development of digital infrastructures within Telco

Specifically, data was analysed using thematic analysis (Boyatzis 1998), following a hybrid approach of theory-driven and data-driven codes. Thematic analysis has been developed as a qualitative method. It follows an inductive logic, with open coding to derive themes from the data. Braun & Clarke (2006) argue that thematic analysis is under-branded as it is often used but not always named. They define it as

> a method for identifying, analysing and reporting patterns (themes) within data. It minimally organizes and describes your data set in (rich) detail. However, frequently if goes further than this, and interprets various aspects of the research topic. (p. 76)

Braun & Clarke also point out that the identification of themes is an active act of interpretation by the researcher. Methodologically, thematic analysis is similar to qualitative content analysis, especially since there are variations like hybrid thematic analysis (Fereday & Muir-Cochrane 2006), based on a combination of inductive and deductive logic (based on codes from the data or from theory, respectively). However, the addition of the concept of themes on top of codes is useful as it helps to structure code books.

The final codebook that emerged from this differs somewhat from the initial one. As expected, Telco employees mentioned a large number of aspects that they thought supported or hindered agility. These included organizational aspects like bureaucracy, technical aspects like the historically grown IT estate, but also other aspects like the difficulty of sharing innovations in a large company. It was interesting to see that tinkering plays an important role – employees managed to adapt some of their information systems to make them more useful for their work and to speed up processes. Also, even the regular workflow of e.g. call centre agents proved to be relatively unstructured and supported by a portfolio of tools. With regards to organizational agility, the concept of ambidexterity was discussed, which helped develop a finer view of agility and its limits in large companies. Adapting of IT was coded in the data significantly more often than Planning IT. There was not much support of IT as infrastructure being amorphous. Both are interesting, but just reflect the way the interviews went, so no conclusions about how frequently these practices are used in Telco in general should be drawn from this. Finally, the initial conceptual framework developed as themes were added and codes moved onto a more conceptual level. Moreover, relationships between codes or themes were identified. For example, it

became clear how managing IT by adapting it can support organizational agility. It was also interesting to see that the notion of digital infrastructures being invisible is useful for understanding the way Telco employees use their IT.

Data displays are an important aspect of this stage. Data is repackaged and presented, first to describe the case study findings (Chapter 5), then to explain them (Chapter 6). Descriptive displays will include the text in Chapter 5, as well as graphs and tables. These will serve as a basis for the explanatory displays (mechanisms) in Chapter 6. These elements will be presented and discussed in detail in the following two chapters.

4.4.4 Developing and testing propositions to construct an explanatory framework

The emerging codes served to construct the explanatory framework developed out of the initial conceptual framework. This is the final stage in data analysis according to Miles & Huberman (1994). The first step in this should be "Testing hypotheses and reducing the bulk of the data for analysis of trends in it". In the early stage of analysis, a one-day workshop was held at LSE. This was attended by the researcher and his supervisor, as well as two senior researchers from Telco. A summary version of the findings was presented and key themes were distilled form the data. From a conceptual point of view, this served to corroborate the empirical results (Wynn & Williams 2012). It also led to further insights as the Telco researchers identified other examples within Telco that can be explained using this framework.

According to Miles & Huberman, the next step in constructing an explanatory framework is "Delineating the deep structure". This is where this study generates meaning, using tactics like metaphors, a chain of evidence and noting relations between variables. It is important to note that these general claims by Miles & Huberman are typical for research based on qualitative data analysis and have been taken up and developed by various streams of research. In this thesis, they are implemented using a hermeneutically inspired approach to thematic analysis and, finally, identifying social mechanisms.

Hermeneutics is one of the key philosophical foundations for interpretivism (Myers 2004). Its roots lie in literary theory and, ultimately, the interpretation of bible texts.

Principles like the hermeneutic circle are essential for qualitative data analysis – e.g. Krippendorff (2004) invokes it at length:

> Avowedly qualitative scholars tend to find themselves in a hermeneutic circle, using known literature to contextualize their readings of given texts, rearticulating the meanings of those texts in view of the assumed contexts, and allowing research questions and answers to arise together in the course of their involvement with the given texts. The process of recontextualizing, reinterpreting, and redefining the research question continues until some kind of satisfactory interpretation is reached. (p. 87)

This thesis uses the concept of the hermeneutic circle, introduced into Information Systems research by Klein & Myers (1999), who name it as one of their "principles for conducting and evaluating interpretive field studies". The same idea is invoked already by Eisenhardt (1989), who recommends iteratively refining hypotheses while comparing findings to the literature. In this thesis, a central element of the analysis is retroduction, the hypothesizing of generative mechanisms, which will be conducted in an iterative fashion.

The question of how to identify these mechanisms in research is not always clear. Many authors refer to the principle of retroduction, but it is not always specified how mechanisms are identified in practice. Wynn & Williams (2012) point out that "[s]pecific guidance for retroducing mechanisms is problematic at best given the inherently creative and intuitive nature of the process" (p. 800). They recommend using "the full range of analytical techniques described by various researchers for generating theory from case study research" (bid.). One common approach is to deduce mechanisms from a case narrative (Allen et al. 2013; Njihia & Merali 2013), but in many cases, it remains unclear how this should be done. This thesis instead applies the staged model for explanatory research based on critical realism by Danermark et al. (2002), which is based on the concept of retroduction, but gives specific advice on how to identify mechanisms. This is one of is the most specific accounts on how to identify social mechanisms in the literature. The stages are (following p. 109-111):

1. Description, which includes the interpretations of participants
2. Analytical resolution, in which the constituent components of a situation are distinguished
3. Abduction/ theoretical redescription, in which components are redescribed based on conceptual frameworks

4. Retroduction, in which the researcher asks for each aspect: What is constitutive for its structures and relations? How are they possible? What causal mechanisms are related to them?
5. Comparison between different theories and abstractions, in which the researcher elaborates and estimates the relative explanatory power of various mechanisms
6. Concretization and contextualization, in which the researcher examines how different structures and mechanisms manifest themselves in concrete situations

This thesis contributes to the literature on generative mechanisms by applying Danermark et al.'s framework and combining it with the notion of the hermeneutic circle, as outlined in this section. Thus, it illustrates the value of this framework and hopes to encourage other researchers to apply it. Following Krippendorff, the retroduction phase of the analysis is described as an iterative process of contextualizing the readings of the case study data and rearticulating its meaning as various generative mechanisms are proposed at different stages of the analysis process. This is illustrated in sections 6.3 to 6.6. These mechanisms are then compared and tested to see which ones have the highest explanatory potential. The process starts from the conceptual framework defined in Chapter 3 and ends by proposing an explanatory framework (Section 6.7) that is seen to be more generally applicable. It is important to point out that no more formal workflow is possible, as qualitative data analysis will always be subjective and iterative. However, such approaches are valuable as long as researchers are clear about their approach, so that readers can decide whether or not they agree.

4.5 Generalization and theory building

The previous section has shown how data is analysed in this thesis. This section reflects on the traditions of generalization in the Information Systems field and on the way findings are generalized and turned into theory in this case.

4.5.1 Generalization in the Information Systems field

Information Systems scholars have given much thought to the question how their research findings can be generalized beyond the original research context. In their

foundational paper, Markus & Robey (1988) define the structures of theories for the Information Systems field and urge researchers to venture beyond the notions of causality that were predominant in the day (e.g. the technological imperative). The case for alternatives to statistical generalization has been made convincingly, e.g. by Eisenhardt (1989), who discusses how theory can be developed from case studies. More broadly, Lee & Baskerville (2003) look at generalizability in Information Systems research and argue for conceptions beyond statistical, sampling based generalizability. In particular, they make a case for generalizing from description to theory, thus strengthening the case for Yin's concept of analytic generalization and for conducting case studies in Information Systems in general. Likewise, Gregor (2006) argues that theory in Information Systems research should provide some level of generalization in order to advance causation and thus explanation.

One common approach for generating theory out of empirical data is the grounded theory approach, which is based on the idea of going into a case without any preconceptions, then generalizing theories out of the collected data (Corbin & Strauss 2008). This has been successfully used in Information Systems research (Vaast & Walsham 2011). However, concerns about the inductive logic of generalization remain (see Popper 2005; Mingers 2004b). Consequently, this thesis will not follow this approach. Instead, it combines elements of deduction (the conceptual framework) with elements of induction (refining the framework as a result of the research, see Chapter 6) in the coding stage. This is inspired by concepts like Weick's (1989) disciplined imagination based on "ideational trial and error" (p. 518) and Alvesson & Kärreman's (2007) notion of "developing theoretical ideas through the active mobilization and problematization of existing frameworks" (p. 1265). In order to develop the explanatory framework, the critical realist logic of retroduction is employed.

Finally, generalization can be supported by research design decisions like the ones discussed here. The relevance of the case study for arriving at generalizable results has been mentioned above. This is stressed by Gerring's (2004) definition of the case study as "an intensive study of a single unit for the purpose of understanding a larger class of (similar) units" (p. 342). He points to the relevance of causal mechanisms in achieving more generalizable results. This can also compensate for the fact that case studies are less suitable for identifying causal effects ("the effect on Y of a given

change in X, taking all background circumstances into account", p. 348), as quantitative research would do. Flyvbjerg (2006) argues that it is indeed possible to generalize the findings of one case study as "formal generalization is overvalued as a source of scientific development, whereas 'the force of example' is underestimated" (p. 12). Similarly, with its focus on causality, critical realism enables interpretive data analysis with more generalizable results. Indeed, McGrath (2013) points out that critical realism's "most important potential contribution to the Information Systems field is the concept of generative mechanisms as building blocks of explanatory middle range theories" (p. 7). This theory generating potential of critical realism has been demonstrated in some of the examples given above (Henfridsson & Bygstad 2013; Aaltonen & Tempini 2014).

4.5.2 Mechanisms

To support theory development, this thesis aims to identify generative mechanisms, which can serve as building blocks for middle range theory. While these are a key element of critical realist research, there is some confusion around the term. Astbury & Leeuw (2010) argue that the concept of a 'mechanism' is poorly understood, with earlier research identifying 24 different definitions. Researchers often follow Bhaskar (e.g. 1978) and define generative mechanisms as causal structures that generate observable events (Henfridsson & Bygstad 2013; Bygstad 2010). Mingers (2004b, p.94 f.) speaks of "hypothetical mechanisms that, if they existed, would generate or cause that which is to be explained". Other definitions of the term focus more on what mechanisms do, e.g. "one of the processes in a concrete system that makes it what it is" (Bygstad & Munkvold 2011 following Bunge 2004) or "the way of acting or working of a structured thing" (Zachariadis et al. 2013 following Lawson 1997). Referring to Bhaskar (1979), McGrath (2013, p.6) points out that "[g]enerative mechanisms are the causal powers of an object, that is, the range of ways in which it can act" and that "in the case of social (rather than natural) structures, Bhaskar argues that these ways of acting are best seen as tendencies".

Generative mechanisms can be seen in the broader tradition of using social mechanisms for explanation in social science research. Avgerou (2013) takes up Gerring's call for the use of causal mechanisms. She argues against research that seeks to explain by refining an existing theory and points out that a stronger focus on

developing causal claims by tracing social mechanisms would be desirable. Such results could constitute building blocks for middle range theory and thus be more broadly generalizable. She defines these mechanisms as "processes composed of entities, actions, and events that produce change" (p. 429) and points out that, in order to identify mechanisms, they should be "traced in narrative accounts of processes" (p. 410) using inductive methods. Her use of the term 'social mechanisms' raises the question how they relate to generative mechanisms in critical realism. The concepts are very similar and follow similar goals. E.g. Avgerou (2013) sees generative mechanisms as "social mechanism[s] in the context of social phenomena" (p. 407). Consequently, generative mechanisms are treated as a subset of social mechanisms here, with the main difference being the fact that they stem from a different ontological tradition. This thesis will use Avgerou's definition of mechanisms as "processes composed of entities, actions, and events that produce change".

4.5.3 Theory building here

Based on these considerations, this subsection summarizes how theory is built here and how that serves to make the findings more generalizable. The meanings of the term 'theory' have been discussed in section 3.1, where, following Miles & Huberman's (1994) general approach to qualitative data analysis, the term 'theory' was defined as synonymous with "middle range theory" and the conceptual framework as a "less developed form of a theory". The conceptual framework consists of concepts and relationships that are iteratively developed into an explanatory framework that serves as the result of the analysis. The logic of mechanisms fits this well: As Miles & Huberman direct researchers towards developing an explanatory framework, generative mechanisms can be seen as elements of such a framework. The process of defining them (following Danermark et al.'s staged model) can be seen as similar to the general approach to qualitative data analysis by Miles & Huberman, as it should be seen as an iterative process reminiscent of the hermeneutic circle. On the other hand, Danermark et al. do give specific advice on the critical realist logic of retroduction (see 4.2.1) and how to employ it to identify causal mechanisms. Consequently, this thesis will start from the conceptual framework and develop a narrative of processes and performances generating agility in Telco. This will be iteratively refined while comparing findings to the literature. This reflects Weick's (1989)

notion of theory building as similar to the process of evolution, as the researcher should generate a variety of thought trials and then select the "best" ones.

4.6 Quality and ethics considerations

Questions of quality and validity have been pointed out throughout this chapter. To summarize, this thesis follows received quality guidelines wherever possible, in particular:

- Miles & Huberman's (1994) outline of the qualitative research process and their quality guidelines
- Yin's advice on case study design and generalizability
- The recommendations for qualitative interviewing given by Myers & Newman (2007)
- Friese's (2014) advice on data analysis using Atlas.ti and Seale's (2002) healthy scepticism of such tools
- The logic of thematic analysis and hermeneutics (Boyatzis 1998; Klein & Myers 1999; Krippendorff 2004)
- Advice on conducting critical realist research (Wynn & Williams 2012; Danermark et al. 2002)
- Thoughts on generalization and theory building (Eisenhardt 1989; Avgerou 2013)
- Ethical guidelines (Tracy 2010; LSE 2014)

4.7 Summary

The research design outlined in this chapter should be appropriate to help answer the research questions developed in the previous chapter. The interpretivist epistemology leads to a focus on people in Telco and their interpretations of agility. This is supported by the critical realist ontology, which at the same time introduces a focus on generalizability through the identification of mechanisms. Both fit well with the methodology of the case study, which, if conducted rigorously, can provide valuable level two inferences as it generalizes to theory. Data is collected using a variety of sources, as recommended for case studies. The process of data analysis follows the principles of hermeneutics and the general tradition of qualitative data analysis as it summarizes findings iteratively into an explanatory framework, which will contri-

bute to a middle range theory of organizational agility. The next chapter will present the findings from the case study.

5 Case Study Findings

5.1 Introduction/ Case background

5.1.1 Outline of project and analysis

The previous chapter discussed the research design used to help answer the research question. This chapter introduces the fieldwork site, Telco, and presents the findings from the case study. It presents an ordered narrative of the findings based on quotes from the interviews and observations. The chapter is structured like this: This section presents the background to the case study. The descriptions of the units of analysis are presented in sections 5.2 to 5.4. Section 5.5 sums up the findings. Presentation and analysis of the findings are structured into three stages. The first one, in this chapter, presents the results from the exploratory research. Phases two and three report on the iterative process of analysis and the explanatory framework respectively. These are covered in Chapter 6.

5.1.2 About Telco

Telco is a large British company operating in the telecommunications sector. The case study looks at Telco's consumer division. In addition to telephony and Internet, it has been offering TV services since 2006. As a relatively late entrant into the pay TV market, Telco is facing strong competition. At the same time, new IP-based offerings like Netflix are becoming increasingly popular, causing senior management in Telco to feel the company needs to be more "agile" in order to compete. The case study explores some projects within Telco aimed at increasing its agility by developing its information systems in order to increase the company's capacity to respond to events in the outside world.

5.1.3 Background: TV and convergence

As television is a central element of Telco's services to its customers, it is important to understand how the technology behind it has evolved. The TV market has changed significantly in recent decades, largely driven by technological change. With the convergence of TV and communication networks, companies from different backgrounds are experimenting with various offers to enhance TV with new features.

Traditional linear TV has been complemented by smart services delivered over IP networks, offering features like additional content (pay TV channels) or catch up on free TV programmes. The idea to transfer TV over IP connections is not new, and Telco has been involved in its development from an early stage. There are various models on how TV is transmitted, from digital-only TV stations (e.g. BBC 3) to digital media players (Roku, Apple TV, Chromecast) to content that is delivered via any browser (Netflix).

Set top boxes are the most visible consequence of this development from the consumers' point of view. Telco is part of the YouView consortium, which offers a service that "provides access to free-to-air Digital Terrestrial Television channels… and to TV on demand (catch-up TV) services via a 'hybrid' set-top box purchased by users, connected with both a broadband Internet connection and a normal television aerial" (Wikipedia). From the consumer's point of view, it is irrelevant how the content is transmitted – it is all displayed on the same device and with the same interface. Interestingly, this also involves Telco transmitting their competitors' content to Telco consumers:

> Many people thought it was a silly idea because effectively, we were offering our competitors a chance to distribute their content to our set-top box. The reason for doing it wasn't to try to sell content services, the reason for doing it was to try to retain broadband customers (i3).

Today, it is feasible to watch television content entirely via IP and without traditional operators like TV channels as middlemen. This is called Over-the-top (OTT) content, and it is what companies like Netflix offer.

Pay TV services have been offered in the UK since 1996 (Ofcom 2014), and have been quite successful, with around 50% of households using them today (Wikipedia 2014). Thus, traditional linear TV (transmitted over the air, via cable or satellite and watched live on a TV set) has been complemented by smart services, delivered over IP networks, that are paid or free and that offer features like additional content (pay TV channels), time shifted viewing, catch up on free TV programmes etc.

5.1.4 Competition/ Owning the network

Telco made a strategic decision to enter the pay TV market in order to monetize its existing broadband network (rather than have companies like Netflix monetize it):

> Netflix is an increasingly large percentage of Internet traffic, so it's a unique situation in that we provide the means for Netflix to reach their customers and don't get any money out of it. (i6)

Thus, the main purpose of Telco TV is seen as driving sales of broadband (i8). As a consequence of this, Telco is mainly focussed on "multi play", i.e. selling customers not just telephone services, but combinations of telephone, broadband and TV (triple play). In the future, these will also include mobile telephony (quadruple play). This is more profitable, but also causes issues, e.g. because of the interdependency of the different products:

> If you want to launch a triple play, but one component can launch something in two weeks, but we are taking x months, it makes no sense. (i7)

The bundling of these packages is quite interesting as they can be based on combinations of different technologies (for example, a combination of cable TV and IP TV), different business models (free TV and Pay TV) and different right owners (e.g. different telecommunication suppliers). Thus, a vast number of different offers is possible. As the case study will show, managing these caused some problems in Telco.

5.1.5 Agility in Telco

In this competitive market, Telco's management felt that the company needed to be able to pre-empt advances made in the industry:

> … that's not very agile when you are in a dynamic market like TV in the UK, where (competitor) will deliberately try and launch something - they know what our development cycles are, they know when our releases are going out. They will deliberately try and launch something at the point it will be difficult for us to hit the market at the same time. We might be then exposed for months afterwards with the wrong proposition. So we have to get away from that "slightly non-agile will do at the moment" (i5)

Agility is thus seen as an important goal, and is mentioned as such in the company's annual report ("we plan to drive down cost and become a more agile and competitive organisation", d4).

5.1.6 Exploratory phase

The first stage of the case study was exploratory. It served to become familiar with the case and its background and identify interesting routes for the research to pursue. Consequently, the first few interviews served to gain an overview of the organization and what employees thought about its agility. The problems of being agile within a large, historically grown organization immediately emerged as a central topic:

> There are the fundamental complexities of actually how to integrate new solutions into our business. We aren't a greenfield business, so if you compare us with a new start-up who hasn't got anything in the ground, it's relatively quick for them to go out and buy some product and deliver it. But you know, it's much more complex when you've got a very old business with lots of embedded products and services. (i4)

It became clear that employees had come to see Telco as not very agile overall (i14, i20, i27). On the other hand, there was a broad consensus that agility – whatever it means – is an important quality for Telco to have. From the first few interviews, a number of projects were identified that interviewees saw as good examples for Telco overcoming its usual inertia and being able to act in a more agile way. What unites these projects is that employees in Telco saw them as successful examples of agility, since some of their colleagues had managed to overcome some of the obstacles that slowed down their work by engaging with historically grown digital infrastructures. A notion emerged that such projects are important as they show how the company as a whole could operate in a more agile way. Three of these projects, OfferMaker, SalesTool and Analytics, were recommended by interviewees as good examples for projects in which they thought Telco had shown agility. They became the units of analysis for the case study. These will be presented next, based on the concepts from the conceptual framework. For each unit of analysis, the background to the project is given, followed by a description of the project and how it was implemented. Finally, there is a subsection called 'interpretations' for each unit of analysis, focussing on the way employees perceive these projects, and in particular, how they see them as supporting agility.

5.2 Analytics

5.2.1 Background/ context

The following sections present the three units of analysis, giving a short background for each, followed by a detailed description based on quotes from the interviews and a section on employees' interpretations of the tools involved, which will e.g. show how successful they think these projects are. The first unit of analysis presented here focussed on a variety of initiatives within Telco to improve analytics of existing data. Sensing what goes on in the market used to be done in an unsystematic way, with little market analysis (i6) or real time analysis of customer data (i1) being conducted. There is now an increased sense of the importance of data analytics, partly supported by the use of big data tools that enable the real time analysis of large amounts of data, like a Hadoop database. This has also led to the insight that existing transactional data can now be analysed (often in real time) and used as the basis for business decisions.

5.2.2 Description

The increased availability of data for analytics, coupled with the introduction of new tools that enable the storage of large amounts of information and its analysis in real time, have led to several new use cases, summarized here under the label of Analytics. Sensing in Telco is traditionally done in a number of ways. These include conferences, a market insights team, monthly customer satisfaction surveys and some data analysis (e.g. usage data on the set-top box, (i1)). As mentioned, interviewees felt that Telco is doing a good job in terms of sensing what is happening in their environment and finding out what competitors are going to do (i4). Beyond this, there have been some new initiatives aimed at better real-time analysis of existing data.

> Probably in the last 5-7 years or so, certainly the research and innovation community here has really ramped up on analytics… So there's all sorts of analytics-based things, but they have been quite targeted in the past. It's only in recent years where data about [Telco]'s services and customer experiences has been more abundant, or the opportunity has been realised more. (i13)

> Big data is only now really kicking in… Where we are now compared to where we were 12 months ago, 24 months ago, we're a long, long way down. (i39)

A good example to illustrate this is the use of TV viewing data for business analytics. Here, a particular opportunity for data analysis is offered by the fact that Telco broadcasts TV via the Internet:

> The [set top] box itself gives you a TV service, it's instrumented in quite a lot of technical detail to record when you change the channel on the TV, when you record something on the PVR [Personal Video Recorder], when you watch an on-demand program or when you make a recording and play that back again… A lot of those – until we started looking at it – were thrown away. (i13)

This enabled very detailed analysis, as in one case where one month's worth of viewing data from a large number of customers was analysed:

> We can say "people who watched the football match on Saturday – what were they watching before that? Where did they come from?" So we found that 30% were watching Football focus on BBC One before they switched channels to watch our program. Where do they go afterward? What do they do in the half time interval? That sort of thing. So that produced a few slides' worth of interesting graphs, … got CEO recognition. (i13)

This use case was instrumental in convincing people within Telco of the value of such analytics.

> Historically, we would have said "here's a brief, let's go out to market and see if we can buy lists of people who are interested in football." The quality of that data, the accuracy of that data, how current that is – it's of very, very variable quality. Now here in our labs, it's proven, absolutely unequivocal – that customer watches every Champions League game. Do you think they are going to stop? No! They'll take [Telco] Sport next year. So that was the most compelling one that we picked as a proof of concept. What you then get is "oh, brilliant! Can you do this? Can you do that? Can you do the other?" (i27)

Real-time analysis is also done on visitors to the Telco website.

> We now have on an hourly basis coming in to our Hadoop data store, feeds of all the page views from [telco].com… Once we start to reveal "oh – you mean you can see that customer X has just looked on the Frequently Asked Questions at 'how do I avoid early termination charges?'. Do you think that customer might be looking at leaving you?" – "Quite possibly." – "Do you

> want to know that, so you can potentially open up deeper retention offers to that customer?" – "Oh yes, please." – "Well, we can do that for you in an hour." Once people realise the power of what we can give them, is that they really start to rip your arm off for more. (i27)

Similar examples of using transactional data to make business decisions in real time include identifying customers who may consider leaving (churn) and inbound decisioning, which helps to identify e.g. customers who ring in to a call centre and predict what their needs are:

> If it's an inbound call, then the advisor receiving the call has a window that pops up as soon as the customer is identified… That identity then makes a call to our decisioning tool that says "tell me about this customer and what should I talk to him about. And what is the likely reason that they're calling?" (i27)

This can also be used to address customers in a more personal way:

> With one customer, [the sales agent] saw on his screen that she had called in five times recently, so he told her he was sorry that she was having trouble. (o1-5)

The tool for identifying churn risk serves well to illustrate how IT and information play together in this case. By analysing customer data (e.g. from website visits) and providing an interface to access relevant information in real time, the digital infrastructure enabled very targeted marketing efforts:

> Let's say you said "I want to contact the top 30% of customers". Randomly, if you contact 30% of customers, you'll get 30% of sales, because people are equally as likely, if you randomised it. However, if you build a propensity model, let's say our churn model, effectively you get 70% of the people who actually churn in the top 3 deciles, so basically, you're getting 70% of the people who are doing an action in 30% of the customers. You call it a lift, which is a 2.3 lift, which is really good for a predictive model.

Such models are based on a variety of data collected by Telco:

> It could be you're out of contract, you called a call centre five times in a month, your tenure with [Telco] as well, so people who've been with [Telco] less time are more likely to leave… It's effectively: The people who did action A this week – how can we use those attributes to model onto the base now, which hasn't done that action? (i34)

Relevant data for this is collected from across Telco and stored in a separate database:

> Q: So which of the [Telco] databases do you use?
>
> A: I actually use all of them. The data gets pulled for me. A massive dataset gets created, which has got about 500 fields in it. This gets pulled from a multitude of databases into it. The data behind it – some of it gets updated overnight, some of it is about to start getting updated every 2-3 hours, and some of it is updated weekly… (i34)

Customers' future behaviour is then predicted using propensity models.

> A propensity model is – you predict the likelihood of a customer doing an action, but you use the attributes of people who did the action last week. If you're buying TV, you basically say "who's bought a TV last week? They look like they had a dog, which was black, which had a red collar". And you use those attributes to predict – you look for customers who also have a black dog with a red collar, and use those attributes and score people via an algorithm to say "they are more likely to buy TV from us". It's more complicated than those, obviously… (i34)

Interestingly, while early suggestions seem obvious, the system is expected to make increasingly niche decisions:

> So it becomes a bit of a black box. And for the likes of you and I to understand, why is it making that recommendation? You're moving it from that intuitive human understanding of "ah, of course! Why on earth wouldn't we do this?" into something that could be much more complicated and is entirely machine driven. I think we're still at the "of course!"… You exploit the power of the data you've got. (i27)

Big data tools have brought some new use cases:

> We're shortening the insight times so radically now, we're getting to really understanding what's happened in a live event a couple of days later, and of course this is really important around planning for [sports events].
>
> Q: So in pre-Big Data times it would have taken…?
>
> A: We couldn't have done it, we couldn't have got it, because the data was not available for use. Because the way the data is structured, it's in log file updates… There wasn't enough room on the data processing systems to store all of the events before you transformed them into those aggregates. (i36)

Tools have to be used according to context, however. Interviewees were aware of the trade-offs between big data tools and traditional databases:

> I listen to conversations that go "maybe we should get rid of this Oracle database in place of Hadoop" – No-o-o! (laughing). Because people need to do ad-hoc queries. My projects have very much been "ok, I write something in Hadoop, but usually, if it's ad-hoc queries, I have to test them in Oracle, because Hadoop just doesn't come back. It just takes too long… It's about understanding when you best use big data [tools], and when you best use existing technology, and maybe we need to come to terms with this. We need to understand this better, I think. (i37)

Some users were even aware that they are dealing with an evolving portfolio of tools:

> Is the most efficient way to get Hadoop to do the heavy lifting at the start of the process to transfer it to that format, and then push it into Oracle to do something else? Or can Hadoop then do the analytics for us and push it into Splunk [a big data analysis software] as a dashboard? We have a portfolio really – what I'm not trying to do is replace all the other tools in existence. In terms of the process I use to sell this to all the stakeholders – and there are lots of stakeholders here – it's definitely one of evolution, not revolution. (i13)

One interesting limitation is that some databases cannot actually be queried for analytics purposes as there are concerns that this would affect the stability of the database:

> There is a lot of data lying around [Telco], but they won't let anyone touch it… The reason that we aren't allowed to look at a lot of the very useful network data we have is because people will say "when you run the query to pull stuff out, it's going to hit my actual production system, and it might fall over, and then we can't actually do business." (i38)

This is partially addressed by the fact that some databases are replicated, so the analytics can run on them (i35, i37).

The way such tools are implemented is also quite interesting. The first step in the analytics process is often one of experimentation, which is generally carried out within the Research team.

> We do have a task in mind that we're trying to understand, for example how we can understand churn. Then we start thinking: This is our target – what

> are the various pieces of data that we can piece together? So it takes a bit longer.
>
> Q: So your work is more or less to look at the data from the perspective of churn and come up with hypotheses on which aspect of the data could predict it?
>
> A: Yes, that would be one of the projects. (i35)

> It's a quite common comment from data analysts: "until I've seen the data, I can't really say what we will do with it". And you have the same when you're dealing with research data – you get the results and you look at it and you think "what does this mean?" (*laughing*). And then, after having looked at it for a few days, you think "oh, I could try this with it". (i36)

Once an experiment works well, it gets formalized and becomes part of the regular business processes:

> I would need to be convinced that it makes business sense to do it, and the cost of that is reasonable and relative to the value that they say they're going to get out of it. I've got a degree of influence over that, I haven't got complete call on it, and at the end of the day, if they say they can get a million pounds potential revenue benefits from something, I'm not going to track them down to make sure they can actually prove that. It's a sensible, pragmatic discussion where they would come and ask for something. (i22)

> We now have processes set in place to formalise some of the experimental work we've been doing. I started out by going to see a friend I knew inside the TV Platform team and said, "I know this platform generates lots of data – can we just have a sample of it, please?" And he would give me an FTP server with a file I can offload from it… So through the formal processes now, and through working with people like the CIO guys and [name], they've set up the official demand where the Consumer data team have said "yes, I want to have a data feed from here to here" (i13)

As the projects become formalized, it is also important to prove their value to the organization.

> If you look at the churn propensity score for a customer and multiply it by the value they're currently, now, you can work out how much they're going to be worth as a customer going forward, so that can be quite a key metric in determining what you should offer a customer.

> Q: So you may be more likely to make a better offer if you see the guy has spent lots.
>
> A: Exactly. By locking them in on a tariff, you might be reducing their value now, but you're reducing their churn risk, therefore your lifetime value increases, which means you're better off as a business.
>
> Q: Which is great – I guess this is the way businessmen have run their businesses forever, and now, because of computer technology, you have it so obvious…
>
> A: Exactly. You can write a computer algorithm and write it into the system, and basically, this is that system. (i34)

5.2.3 Interpretations

Looking at how people in Telco interpret the success of these initiatives, it was found that they thought the use of real time data analytics has already brought some specific benefits:

> Beforehand, it was agents having access to every single offer in the company, so you'd have 50 different recommended offers which you could choose from. So agents would scroll through it and basically sell [customers] a product. However, when we have this recommendation device and the insight, what we've seen is about 3% increase in broadband regrades, and a similar increase in TV acquisition, so effectively, all the metrics look good. (i34)

> The sales agents love it. Mainly because some of the insights which pop up are good. Their favourite one is, you can pop up a customer's tenure with [Telco] up there. So as a welcome to the call "thank you, sir, for being with [Telco]. I can see that you've been with [Telco] for 20 or more years, thank you so much for your custom. Let me see what I can do with you. Let me see what packages I can offer you." It's just a nice acknowledgement – "thank you very much for your service" sounds a bit cheesy, but it's nice in a way – "hello sir, how are you doing". (i34)

Interviewees mentioned some limitations of these new practices as well. One issue is convincing people of their benefit:

> One thing I have learned – it's not necessarily just the technical strengths of the project that make it a success, it's convincing people. (i35)

Interviewees were also aware of the danger of jumping to premature conclusions.

> The idea is to try to have an institution's practice which do things like declare hypotheses up front, run controls and don't allow … the sort of practices of the Today programme cancer scare story. All the time you have "eating avocados makes you mad, and we know that because we followed 6 people, and one of them went mad, and he said once that he quite likes avocados, so that's what makes you mad." Of course, you find millions of those things all the time. It doesn't matter what's actually in the data, you'll find it. The only way you can stop these things happening is by having an institution and a set of behaviours and controls, questions, challenges. (i36)

On the other hand, they are trying not to be too constrained by such concerns.

> But if we said, ok, we impose the process of science as it's widely understood on the use of data in business – what would happen is you get no answers while your competitors have 40 answers. A bulk of those answers would be useful. Some of them would not be useful. You would have no value, they would have some value, and the chances are that they would beat you and you disappear – the Darwinian nature would eliminate companies who did that. (i36)

Concerns about security and regulations also slow down these projects (i22, i13).

> Some of the things that do become difficult for us – for example, the Hadoop installation that we are working with has been made to be very, very secure because it is holding customer information, so it's very sensitive information. In making this really, really secure, they've actually removed a lot of features, you see? Because of this, you have a very secure environment, great, but you can't do much in it. (i37)

> There is an Ofcom requirement to store the emails and Social Media in OneView – correspondence is documented, emails, letters etc. Advisors are expected to put in notes after every call. (i15)

Also, there is an amount of organizational processes to observe:

> Q: So even if you come up with a relatively obvious rule like "this guy has children, let's offer him children's TV", then you still have to double check it with the commercial team?
>
> A: Exactly. Let's say you're downloading Mickey Mouse films all the time – there's a cost associated with downloading a film, and therefore some people you are better off as a company to leave them downloading them, and some people it's better to lock them in at that spend with a subscription based tariff. (i34)

Finally, interviewees found it hard to spread knowledge of such tools in a large organization:

> Aperture is a good example. I guess, if you met [name], … he designed the thing 6 or 7 years ago. It was only last May, a year ago, I stumbled across it. As soon as I saw it, I thought "wow – this is amazing. This is doing stuff we dreamed about." (i39)

5.3 OfferMaker

5.3.1 Background/ context

The next unit of analysis looks at the way Telco employees enter data into their systems to create new offers. Several interviewees commented on difficulties in doing this, which was diminishing Telco's ability to respond to competitors' actions (i1, i5). Offers (also called promotions) are a combination of services, prices, and add-ons customers get when they sign up. Thus, they are essentially the products Telco sells, and consequently very important for the business' success. As shown above, the complexity of Telco's products has increased continuously over time. Initially, telephony was the only product. This has been extended with broadband, TV and mobile phone plans, so creating offers nowadays involves combining elements from these different areas. Telco's existing IT was unable to keep up with this growing complexity and increasingly slowed down the process of responding to the market:

> You go back to the middle 80s. We built a system called CSS, which is built upon IBM database technology… and it's become very difficult to get off it… So we already knew a long time before that that we needed to get off onto newer technologies which allowed us to be particularly more agile in the market… you're looking at massive waterfall cycles to do that. And they tended to start a year before in terms of requirements capture, so that makes you extremely non-agile, right? Very, very slow. (i5)

Telco's business operations are run using a suite of tools called the CCP stack (i2). This is a modular system, made up of "certainly more than 50, probably closer to 100 different systems" (i2). Initially, offers had to be created and edited by the IT team making changes to the systems' source code. This could only be done during the monthly updates of the CCP stack. Consequently, creating a new offer could take several months (i6). Specifically, there were issues with responding to offers by competitors in a timely manner.

> We were just about to launch a new set-top box. We were going to charge – I can't remember, but let's say £70 for the box itself. We were going to launch it, say, next Friday, 10 days or so away. I came into work in the morning, and there was an email from the insights team I just mentioned, saying "[competitor] have just reduced their set-top box to give it free to customers"… So that caused us no end of problems, because our systems are just not agile enough for us to be able to make changes. (i1)

> Things like broadband prices, TV package prices can appear in the paper one day from [competitor] and if you've got to wait 6 months before you can do your price change, it doesn't really work very well… When I first joined, I was amazed. People were saying to me how it costs six figures to change the price... how can it? You just change the price, but it's very, very complex. (i6)

This is partly due to the way the Telco's information systems have grown over time, and to decisions made previously.

> So I think our systems, like you said, are built on, and built on, and built on since the 1980s, and what you could benefit from is building from scratch – that's never going to happen, so it makes it very difficult to turn things around. (i6)

> Rather than making a promotion item out of bits of individual products from different product lines and then pricing it at the point we sell it to the customer, no, instead we priced it at the time when we put it in the catalogue. The truth is that, in today's bundled world, we sell almost nothing at this price… That's one of the fundamental reasons why we ended up building promotions in IT releases because we needed the flexibility of having coders. At the end of the day, it's nothing like code that does anything useful… That's the issue. Which then got us into a place where the managing director said, "why have you built me a stack where I have to spend £1,500 to £2.000 per promotion to create promotions, and it takes me months and months and months to build the damn things?" (i5)

In reaction to this perceived need for agility and the IT shortcomings described, Telco has done a number of improvements and workarounds to its information systems. Specifically, a new tool (here called 'OfferMaker') was introduced in 2013. This has been added on top of existing systems and provides product managers access to the existing database where offers are stored. It enables them to make

changes to offers in the database rather than having the IT team make them in the code.

5.3.2 Description

As shown above, creating offers is a complex process that involves combining offers from the different areas of telephone, broadband, and TV. There is a commercial team that is in charge of market analysis and general strategy. Their requirements are passed on to the product managers, who then create specific new offers. Offers then used to be implemented by the IT delivery team (often off-shore) before the introduction of OfferMaker. Moreover, as offers frequently change, people would add additional complexity to the process by requesting changes after submitting their requirements:

> [If you were] taking a piece of paper with the requirements to the IT person – they took that and started typing it in, they could get it wrong. And if I've given you the piece of paper and go, "hold on – I need to change that piece of paper!", they'll go – "I have a CR [change request] process over there. Do you want to go and engage my CR process?" What we do now is, because it's my team typing the things in, yes, if the proposition manager says "can we change it?", there's not as formal or rigid a CR process, because we're the same organisation, if you tell us in due time, yeah, we probably can change it. It's collapsed down that process a whole lot. (i9)

Telco's staff came up with a number of ways to work around the issue.

> So I've then got to build ten times as [many offers] as I thought I would need in the first place, but spend well over 1.5 or 2 grand per promotion that I actually use, I may be spending 15 to 20 grand because I built 9 others that we'd have to build ahead of time and in the background, just in case one of our competitors comes out with something similar. (i5)

However, the underlying problem remained that the existing systems were not flexible enough to allow fast changes of offer details or prices. This issue was addressed by OfferMaker, which started out as an individual project by one employee of Telco. This speeds up the process of responding to competitors by enabling non-technical staff to make changes to offers. No programming skills are needed any more as the changes are made in a database rather than in code

> That was a project to build some tools that allowed product managers to… build some new promotions, offers – and to change the attributes of some of

> the promotions. And it does this effectively by manipulating attributes in the [product] database directly, but because it's a GUI [graphical user interface] front end, it offers a measure of protection. (i2)

It is interesting to note that this started as an initiative by one employee:

> So that's the background against which [name] sits down and thinks about, how would I do this differently if I had a different world? We can't do a lot right now about the fact that we've got the pricing down at the promotion level, that's a really stupid idea, but it's difficult for us to get away from it. We might do it in the long term, in the short term, we can't. But what we can do is to try and automate lots and lots and lots of the data pull that controls the creation of all of those 10 promotions for every one that you think you might want to use… So that was basically the idea behind [Offer-Maker]… It's one of those things where when you've done it, everybody says "well, that's bloody obvious", but actually it takes a slightly mad genius like [name] who drove it. (i5)

5.3.3 Interpretations

Looking at how Telco's employees evaluate the impact of the tool, it was found that OfferMaker had a significant impact on their work, and employees were generally very pleased with it.

> It was so successful, obvious thing to do, it paid for itself inside the same financial year. (i5)

> It's taken lead time of several months down to potentially couple of weeks. Now, they still have their own contention – but it's nowhere near the level that was there – and even now we're looking to make vast increases. (i7)

> I observed people using it. It is literally a case of you going on a system and in the space of 10 minutes, you've defined a promotion. The good thing about [OfferMaker] is it uses something existing as a template. If you think about it, with any company – what is a special offer? It is generally the same package, you just give it different price. So it uses that concept – it basically is a copy-and paste. You copy something that's there and you tweak the name, you tweak the discount and then you just send it... (i7)

> What we've done is cut out the whole IT department/ piece of paper/ "can you go and do that?" We have a tool now that allow us to type in our sales,

> what's on the paper, and then there's a largely automated delivery mechanism that allows that new special offer to appear in the system. (i9)

However, there are some limitations.

> It was very successful, I think it over succeeded the target of the project, but still, it's oversold in some quarters. Senior management think you can do more stuff than it can, but that misunderstanding in their consciousness is changing the culture of the business and allowing us to do these more rapid changes more often. (i9)

> There's product managers we're bringing off the sheet, … and they go "are you people mad? What is this?" because it doesn't look pretty. People who don't understand our operational support system go "this is an odd process. Why can't we just build a million of them? You know, it's just rows in a spreadsheet somewhere". So there's a lack of understanding of the IT estate, that means, at times you have to hold people back, but they haven't seen the evolution, so they don't know what bad looks like, they're just seeing what today looks like. (i9)

Also, the tool does not work for all products yet.

> [OfferMaker] doesn't really work for TV… The underlying product model that we have for TV is different from the product models for the other products for no particularly good reason, so we have a project running this year, we are going to bring TV in line with the other product models, which means the [OfferMaker] tool will work for that (i2)

5.4 SalesTool

5.4.1 Background/ context

The final case researched in this study is SalesTool (a pseudonym), a project which, like OfferMaker, aims to improve upon a historically grown system. SalesTool has significantly reduced call handling times in Telco's call centres. SalesTool is an added layer on top of the existing customer data base (CRM) system that is designed to look like the Telco website and offers call centre advisors all the information they need. The tool also taps into the customer data from the real-time analysis described above, enabling sales agents to make individual offers to customers based on factors like their churn risk or their future value for Telco (i34). The need for a better solution became apparent as OneView, the Siebel CRM system used to manage orders, caused a number of issues.

> The trouble is that all of the data is locked into the Siebel database, which is unwieldy and difficult… the Siebel front end screens are… a mess maker's charter. You can do almost anything with those front end screens on the data… So if you give [sales agents] the ability to make mistakes, these are people who will make mistakes, and so, if you give them the Siebel front end, you end up with a mess. They'll screw up your data, there's almost no validation in the back end. They can do almost anything they like with the record. And they do." (i5)

This was partly due to the fact that the system was not very suitable for the task:

> The OneView system, I read all about it years ago. When it was purchased, it was made by a guy in Germany, because it's part of Siebel, isn't it. And it's actually meant as a recording system. It was never meant to be used as an order entry system, so it can't handle – I don't think personally – it can't handle the volume of orders that we've been asking it to do on a daily basis. (i25)

> OneView seemed like a bit of a rushed creation – every single quarter, they seem to bring something out that just improves it that little bit. The problem is that [Telco]'s products are rapidly expanding as well. To me, that – it feels like they bolt bits into it time and time again, made it more complex. I don't know what the answer is to that. I was saying to my manager – I'm hoping what happens is as our product portfolio settles … that they will be able to rationalise OneView a bit more, clean it up. I can only presume that's going to be in the pipeline. (i18)

Agents reported on a number of issues using OneView in their daily work, including the fact that the interface is confusing and contains many items that are not necessary for the daily workflow (i31). The software also has issues that make it hard to use even for experts:

> Sometimes, you sit here and you struggle to submit an order for about an hour and a half, and it comes up with a problem and another problem and another problem. I've got one actually – I'll show you in a second – of my own. It was a really easy solution, but OneView would not put the order through. It just keeps looping – you get sometimes caught in a loop, and you can't fix it, so it's crazy. Sometimes it drives you crazy. (i25)

Moreover, agents have to add all elements of packages separately by selecting them from a long list of items. This is made harder by the fact that this list contains many

items that are never used (i25). Because of these shortcomings, OneView was seen as an obstacle to agility:

> There's a number of different problems we had with that. One is that basically, it's a very powerful tool, but in some ways it's far too powerful for our agents. Training overhead is huge, and possibility for errors is huge. (i2)

> If we worked in a way to either upgrade or improve that system, then that would have a direct impact on how agile we were in order to turn things around. And I'm not sure it's just a case of increasing resources, I think it is a case of improving that IT infrastructure. (i6)

At the same time, it was found that customers were able to submit orders through the website faster than agents did through the OneView tool (i23). This insight led to the development of a new tool (here called SalesTool) for agents working in Telco call centres. Again, this initiative was started by a single employee – in this case, a sales agent who shared their idea with a Telco executive:

> I think it was the chief executive of Consumer. So, not small fry, really big fry… He used to do these roadshows and get feedback from agents, and one of the feedbacks in one of his sessions was "if [telco].com is easy enough for our customers, why don't we just use that for agents?" So I think that's where the idea came from… I think it came from the agent feedback. (i23)

5.4.2 Description

SalesTool was planned as an additional layer on top of the existing tool, but with a simpler, more intuitive interface.

> Effectively, it's a layer or platform that sits before OneView. [SalesTool] and [telco].com are based on the same off-the-shelf framework, and we tailor [SalesTool] slightly more to suit some of the agent activities and things that they do, so the agent can do a little bit more in [SalesTool] than the customer can do with [telco].com. (i23)

While it accesses the same database, it uses the interface from the company's public web portal, modified and extended to match agents' needs. Specifically, agents are supported with a linear workflow following the order journey customers go through during a typical call. Throughout the process, SalesTool gives them exactly the information they need, e.g. relevant customer data, or reminders of what they have to

tell customers. This includes legal disclaimers that agents must include. This is illustrated in the screenshot of the system (Figure 8).

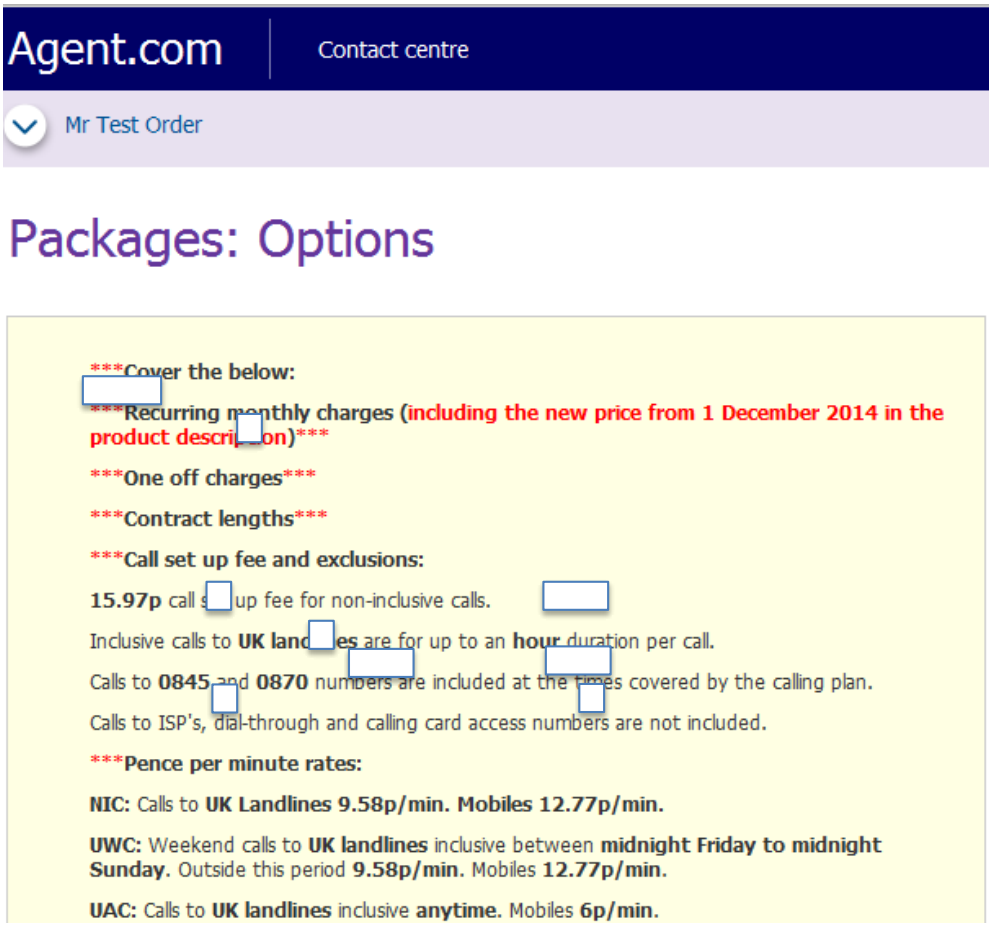

Figure 8 Screenshot of SalesTool (redacted)

The difference to the previous tool was obvious in the observation sessions conducted as part of the case study.

> The first obvious difference [to OneView] is that it looks different – it was modelled after the shopping function on the [telco].com website. Also, the tool has obviously been created to support the agents' work flow… The tool also gives a list of negative and positive insights and makes recommendations on what offers to make to the customer. (o7)

Interviewees particularly pointed out that OneView users in the call centres were involved in the development to ensure the system matched their needs:

> I think [SalesTool] has been a really good example of where the users were involved throughout and therefore what was designed really does work for them. So from my perspective, that's what I see as the ultimate way of getting things done. So that was really, really good. (i20)

Paradoxically, there were some issues with SalesTool at first because it appeared too simple:

> So they did not trust [SalesTool] to start with, they did not trust that the right statements were there… And what we found initially was that call handling time went up. It doubled. It went up hugely… We observed that they were saying a lot of the stuff twice. They were saying the statements when [SalesTool] presented them to them, but they were also going back to the old system and using that and saying stuff again, and they were also doing a lot from memory, because they were thinking "hang on, I haven't said that bit about this". (i20)

This, however, was soon resolved:

> And when it rolled out bigger, bigger, bigger, there was a video that was done by [Telco] regulatory team saying "we endorse this, these statements are correct. Use this, it's a fantastic thing." And the advisors that had been part of the trial team and who'd been part of the work we'd done to write the statements, they went around to call centres as [SalesTool] was rolled out and evangelised about it, so they could tell other advisors "trust this, use it, this is right". So it was all about trying to build the trust in it. What we find a lot in call centres, they have so many systems changes, that trust is a big issue. (i20)

However, the co-existence of the different tools also points to a general issue in Telco – the diverse, historically grown set of information systems. As one of the sales agents commented:

> The systems are a bit clunky. They could be better, they could interact a lot better. There's a lot of copying and pasting. They do try to get them better, but sometimes they're just not…
>
> Q: Looks like it's all a historically grown workflow.
>
> A: It's just bits added on as it goes. (i17)

Management is aware of this, as confirmed by a process architect:

> We are getting better. But anything that has ever been developed in the IT space, we've got at least one of them. Every single operating system under the sun you will find somewhere in the company. That becomes one of the challenges. If you want to change something, there's so many different operating systems, so many different types of hardware. (i39)

5.4.3 Interpretations

Looking at how people in Telco perceived the effect of SalesTool, it became clear that they think it led to a number of expected and unexpected improvements. Some key metrics were communicated in an email from Telco:

> Training time was reduced from 3 months to 10 days
>
> Call Handling time was reduced by 20% (target was 50%)
>
> Sales conversion rate increased 6% (not anticipated)
>
> Sales attachment rate increased 6% (not anticipated). (d1)

Interviewees also commented on significant increases in speed when working with the new tool:

> When we first started placing orders on OneView… a customer would take anything up to an hour to place an order, which was quite tedious… a lot of awkward pauses, a lot of apologies, because there was no linear order journey. Confusing.
>
> Q: How long would it take now?
>
> A: Now, including all the compliance, around 12-13 minutes or thereabouts, depending on the conversation… (i30)

The main difference that was commented on by agents is that the tool made their work a lot easier.

> Q: So it's a really simplified view of OneView?
>
> A: Yes, absolutely. Because OneView has got a lot of room for manipulating the order when there is a problem, which is handy for us, but when you have people going in and placing orders day in and day out, you don't want them to deviate away from the standard steps process. (i18)

> I've gone through training with new entrants quite a few times now, and they just find it so much simpler, they're used to placing online orders in general, to shopping, things like that. (i30)

In particular, the tool follows the script of a normal sales call and shows the exact information needed at each stage.

> If you look at [SalesTool], everything is exactly where it should be said. You're talking about purchases for TV, it will tell them when you actually

> order that product, whereas on OneView, it was just – you told them whenever you felt like it. (i33)

Because of this simplicity, training time has also gone down significantly.

> They do 21 days now, so a lot shorter than the 12 weeks that we originally had, and a lot of that is down to that you don't have to write as many notes, remember which part to deal in which order or selecting the correct products, because all of the information, all of the links, are available there." (i30)

Another consequence of the simplified work flow was that agents find they have more time now to focus on the customer rather than on their tools:

> It was really positioned to them as "this is to make your job easier, this is so you can focus on the selling", which is what they get their bonus for, to help them understand that. On the whole, they did really like it and they could see the benefits of it. They could see how it would speed them up and enable them to sell, which ultimately – it's for use with sales advisors initially. So it was really positioned like that for them, fitted in their ways of being bonused and rewarded. (i20)

> I remember having a conversation with some of the advisors when we first trained on OneView – say hello to the customer, have the conversation, but then turn away from the computer, because it was that much information that you had to remember you had to do, you would forget about the conversation, whereas now, they can do both at once. (i30)

As the system is an extension of the existing OneView system, there are still some conflicts over which tool to use at what time. This is especially true in teams that are working on more complex cases (i32).

> Q: So if I start here as an agent, I would do most of my work in [SalesTool], but would also have OneView in the background?
>
> A: Yes. You would always have OneView in the background.
>
> Q: Does that mean I'd also get some training? I heard OneView is really hard to learn.
>
> A: Yeah. We've been trained on some things with OneView, but not everything. There's certain things… you have to do in OneView. So you are trained to do that in OneView. But most of the time, a lot of the things that you couldn't do anyway, you can do it in [SalesTool]. They really have

> made it a lot easier. Even in the last nine months, they have made some significant changes to it. (i31)

Because of the success of the tool, management is pushing for broader use (i33). However, for pragmatic reasons, some agents reported using it more often than they should:

> The problem is, we have to use OneView. Because even to get into [Sales-Tool], you have to use OneView first. Considering they want advisors to use OneView less, in order to use it in the first instance, to get to the tool that they need, it's kind of nullifying the whole purpose to avoid using OneView. (i30)

> But because now, we're so busy in different departments, it's better for me to learn what to do in OneView than to spend 20 minutes waiting to get through to speak to one of my colleagues in a different department, just because it's so busy. (i31)

5.5 Chapter summary

The case study has presented a number of examples for projects which Telco's employees regarded as agile, even though they see the company itself as not agile. The cases presented here contribute to an emerging image of how Telco engaged with its digital infrastructures in order to become more agile:

- It was found that, while historically grown digital infrastructures may constrain organizational agility, there are examples of how users can successfully engage with them in order to shape them.
- The case study illustrated how IT, people who design and use it, and information all play an important part in digital infrastructures.
- Thus, agility lies in getting digital infrastructures to support activities of sensing and responding swiftly, while at the same time being conscious of the limitations they bring, thus balancing the perceived need for agility with the need to preserve the digital infrastructures.

Table 12 sums up some key findings.

Case	Analytics	OfferMaker	SalesTool
Issue	- Lack of business insight - Not using existing data	Creating offers too slow, expensive	Existing tool poorly supports sales agents
Change	Experiments with real time data analysis	Add-on to existing tool	Add-on to existing tool
Result	Increased provision of information enables better business decisions	Easier operation within the DI thanks to new tool	Easier operation within the DI thanks to new tool
Digital infrastructures:			
IT	- Legacy systems running the business - New tools, e.g. Hadoop database	- Legacy systems: inefficient - New tool as add-on	- Legacy systems: inefficient - New tool as add-on
People	- Research team experimenting with tools - Other teams picking them up - Management benefits from insights	- Complex process involving several teams - Bottom-up innovation to speed this up	- Sales agents in call centres - Bottom-up innovation: one agent's idea - Agents involved in tool development
Data	Abundant data produced in on-going operations	New offers on piece of paper	CRM data, e.g. products, offers, existing orders
Information	Existing information duplicated in Hadoop - fast, secure	Offer information entered into database - now by everyone	Existing information from CRM presented in a more efficient way

Table 12 Findings summary

The next chapter will apply the conceptual framework to these findings in order to answer the research questions.

6 Analysis

6.1 Introduction

6.1.1 Approach

The previous chapter introduced the fieldwork site, Telco, and presented the case study findings based on descriptions of the three units of analysis. This chapter applies the conceptual framework and the research design to these findings in order to answer the research questions. Starting from the initial research question, "How can digital infrastructures support performances of agility in organizations?", the following specific research questions have been defined in Chapter 3:

- **RQ1** How do digital infrastructures enable/ constrain performances of agility in organizations?
- **RQ2** What is the role of people within digital infrastructures in performances of agility?
- **RQ3** What is the role of information within digital infrastructures in performances of agility?

As discussed in Chapter 4, the analysis needs to proceed in an iterative fashion (Danermark et al. 2002; Eisenhardt 1989). Three stages are distinguished, here called exploratory, iterating and explanatory. The exploratory stage (Chapter 5) started from the conceptual framework. In this stage, the goal was to become familiar with the case and identify potential areas to focus on. The iterating phase is where hypotheses are developed and tested against the data and previous literature as they are refined and fleshed out. Specifically, generative mechanisms will be proposed and tested for their explanatory potential at this stage. This will constitute the main part of this chapter. Finally, the explanatory phase summarizes the findings into an explanatory framework. As discussed in Chapter 4, the analysis is structured using Danermark et al.'s (2002) staged model for explanatory research as it is one of the most detailed accounts on how to conduct research using a critical realist ontology. The first stage of this model, Description, has been covered in Chapter 5. The present chapter covers the remaining stages. It is structured into the following sections (see Table 13):

- 6.2, which illustrates the constituent components of the digital infrastructures, as well as performances and relationships involved, and redescribes them using the terms of the conceptual framework,
- 6.3 to 6.6, which describe various iterations of the analysis process and show how mechanisms were proposed.
- 6.7, which summarizes the results by presenting the explanatory framework and uses this to answer the research questions.

Thus, this chapter identifies potential generative mechanisms, discusses their explanatory potential, and summarizes them in an explanatory framework. The next chapter relates this framework to the existing literature and discusses how it adds to it.

Goal	**Explanatory research stage (Danermark et al. 2002)**	**Chapter/ section**
Become familiar with the case and its background and identify interesting routes for the research to pursue	1. Description	5.2-5.4
	2. Analytical resolution	6.2
	3. Abduction/ theoretical redescription	
Develop hypotheses (propose mechanisms), test against the data and refine	4. Retroduction	6.3-6.6
	5. Comparison between different theories and abstractions	
Summarize the findings into an explanatory framework containing generative mechanisms	6. Concretization and contextualization	6.7

Table 13 Analysis stages – overview

6.1.2 Iterations

After the descriptive phases covered in Chapter 5, the next stage in Danermark et al.'s model for explanatory research is retroduction, in which causal mechanisms are proposed to explain the phenomena in the study. The conceptual framework developed in Chapter 3 was the starting point for a number of iterations in the analysis process, which finally led to the explanatory framework presented here (summarized in Figure 9). This chapter reports on how the framework was developed. The iterations were inspired by the various elements of the conceptual framework, as well as findings from the case study. Consequently, the focus shifted from the benefits of

digital infrastructures (iteration 2) to the limits of agility (3) and the role of information (4) before arriving at the concept of digital infrastructures as a lens (5). These iterations correspond to sections 6.2-6.6 of this chapter. Table 14 gives an overview.

Iteration	Origin	Concepts	Findings	Mechanisms	Section
1. Conceptual framework	Literature review: agility, digital infrastructures	Agility as a performance within a DI (consisting of IT, people and information)			3.5
2. Benefits of DI	Elements of DI: IT		Benefits, e.g. Flexibility, Modularity, Generativity	Invisibility, tinkering	6.3
3. Limits of agility	Case Study	Bounded rationality		Bounded agility, bounded generativity	6.4
4. The role of information	Elements of DI: Information	Information		Information growing, cooking, serving	6.5
5. DI as a lens	Elements of DI: People		DI should be understood as a lens to look at IS in organizations	Agilization, infrastructuralization, informatization	6.6
6. Explanatory framework	Previous iterations	DI, Information and Agility			6.7

Table 14 Analysis iterations

6.1.3 Method and limitations

This chapter presents the iterations of the analysis and the possible generative mechanisms that have been hypothesized in the process. As discussed in Chapter 4, there is no simple way to define such mechanisms. Consequently, the method has its limitations. As illustrated above, Wynn & Williams (2012) speak of the "inherently creative and intuitive nature of the process" of retroducing mechanisms (p. 800). As the process is not systematic, it will only consider a limited number of possible mechanisms. However, the search is guided by the conceptual framework, which restrains mechanisms to the areas of interest identified at the outset. This has led to

various areas of focus throughout the process of analysis. The mechanisms that emerged through this process are introduced here. Mechanisms are then compared in order to find out which ones have the highest explanatory power. Findings are summarized in Table 17 below (p. 160). The most promising mechanisms are collected in the explanatory framework (Figure 9). The analysis then proceeds to examine how the selected mechanisms manifest themselves in concrete situations. This is equivalent to stages 5 and 6 in Danermark et al.'s model.

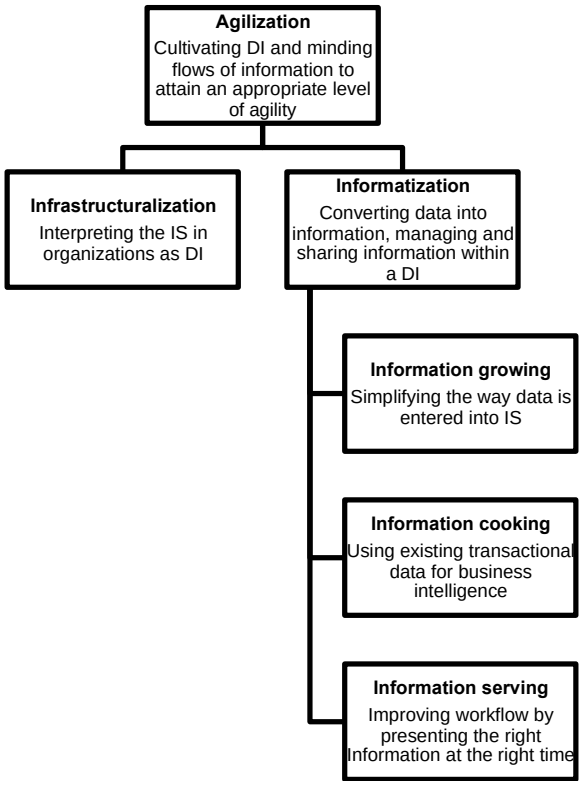

Figure 9 Explanatory framework

These iterations will be presented next, with a focus on the process of proposing and selecting generative mechanisms.

6.2 Resolution/ Abduction

6.2.1 Digital infrastructures and their elements

As an overview of the units of analysis has been established, this section identifies the constituent components of the digital infrastructures observed and describes them in the terms defined in the conceptual framework (Chapter 4). Together with the descriptions of the units of analysis presented in Chapter 5, this covers the first three

stages (description, analytical resolution and abduction/ theoretical redescription) in Danermark et al.'s (2002) model for explanatory research, which is used to structure the analysis in this thesis. Based on the three units of analysis presented above, the following three digital infrastructures can be defined:

In the case of Analytics, the key elements of the digital infrastructure are:

- Information that exists within the business – e.g. transaction data from CRM systems, website visits, TV viewer logs
- Tools that produce the information (e.g. CRM, web shop, IPTV infrastructure)
- Additional tools for analytics, e.g. Hadoop, decisioning tool, dashboards for sharing results
- People running analytics experiments, e.g. research team
- People in other parts of the business using information from analytics, e.g. marketing teams, sales agents

In the case of OfferMaker, the key elements of the digital infrastructure are:

- The Telco web shop that presents offers to customers and sells them
- Operational system – CCP stack
- OfferMaker as a later modification of the digital infrastructure to enable easier editing of data
- People creating and manipulating offers
- Information: e.g. details of offers, market data on competitors

In the case of SalesTool, the key elements of the digital infrastructure are:

- The OneView CRM system. This has evolved to be the main tool used for processing orders, even though this was not the intended purpose of the tool.
- SalesTool as a later modification of the digital infrastructure to facilitate agents' workflow
- Sales agents in the call centres using the tools and e.g. negotiating which tool to use for which purpose
- Information (e.g. from real time analytics) supporting agents in their work, e.g. customer history

This illustrates how the elements of digital infrastructures postulated in the conceptual framework (IT, people and information) all play an important role in constituting digital infrastructures. These will be considered in more detail next.

IT is at the heart of each of the units of analysis. As Telco is a large, historically grown company, its IT estate is quite heterogeneous and has evolved over time, which has proved a considerable constraint to agility, as the grown systems make it hard to make changes that appear trivial (as the example of OfferMaker illustrated). The OneView CRM system is a good example of how a tool has acquired a role (processing orders) that it was not very suitable for from the beginning, and how it is now so engrained in the offers digital infrastructure that it is hard to replace it. Often, however, the systems are modular enough to allow for some degree of modifications, as seen in the cases of the offer and sales infrastructures. In the case of analytics, such existing tools serve only as the source of information, whereas new, separate systems (like the Hadoop database) were implemented to serve the growing need for analytics.

Tilson et al. define digital infrastructures as sociotechnical systems – they become useful and generative only through the people using and forming them in the context of an organization. Thus, it is important to understand the role of people as users and developers in digital infrastructures. In the case of offers and sales, it was illustrated how significant improvements of the grown IT were implemented because individual users were frustrated with the tools and perceived them as slowing down the organization. By making them easier to use, they supported their evolution and made them more useful for the rest of the organization. Especially in the case of offers, a complicated process that involved product managers sharing their requirements informally, sometimes on a piece of paper (i9), has been simplified so that they can enter the data into the system themselves. Even in the use of the finished systems, people still play a significant role, as illustrated by the sales agents switching between the (old, more powerful) OneView and the (new, simpler) SalesTool autonomously. In the case of analytics, there is a separate team (the Research team) running experiments which then support other teams in the organization. Their challenges include communicating with these teams in order to understand their needs as well as sharing any new tools they develop, so that their potential users may learn

about them. Finally, people decide what data is relevant for them and trigger the capture of data or flows of information.

Information is conceptualized here as an element of digital infrastructures. It is interesting to see how it plays a central role in each of the three cases. In the case of offers, the main goal of the digital infrastructure was to process information. After the change introduced with OfferMaker, the process of creating or entering information became faster and more flexible. In the case of sales, the significant change lay in the way the existing information was presented to its users. In the case of analytics, the main goal of the digital infrastructure is to collect information from around the business and present it to the right users in the right way.

6.2.2 Performances of agility in digital infrastructures

As discussed in the conceptual framework (Chapter 3), agility is conceptualized as a performance in this thesis. Specifically, its focus is on the practices enacted by users as they engage with digital infrastructures. A particular focus will be on performances of responding, which are conceptualized as the interactions between IT, people and information within digital infrastructures. As the case study revealed, respondents do not see Telco as agile overall. However, they see agility as existing in projects like the ones described above. These result from social practices, i.e. the way individuals or the organisation engage with digital infrastructures.

In the offer infrastructure, users innovated to create OfferMaker. It was interesting to see that this started as a project by one individual who was frustrated with the historically grown IT estate, which had led to the curious situation where offers that needed to be updated constantly could only be edited in the source code of the CCP stack of tools (i2). However, because of the modular nature of this stack, one "mad genius" (i5) individual was able to create the OfferMaker tool. As stated in the conceptual framework, to be agile, a performance must contribute to change as well as to one or more of the following:

- perceived economy
- perceived quality
- perceived simplicity

It is easy to see how OfferMaker fits these criteria. The tool was found to be very successful in economic terms ("paid for itself inside the same financial year", i5). Its users are happy with its quality and simplicity as well, as evidenced by the generally positive feedback.

Likewise in the sales infrastructure, another individual initiative (the idea submitted by a sales agent) led to the creation of SalesTool as an added layer to the OneView CRM tool. This enabled agents to interact faster and better with their customers. Again, this performance contributes to change and the results are perceived to contribute to economy, quality and simplicity. For example, interviewees perceive agents' phone calls to be shorter (d1) and of better quality (i24).

In the analytics infrastructure, users (e.g. the research team) undertake continuous experimentation with ways of data analysis. If an experiment appears successful, it is formalized. The users acting on the analysis are also part of the digital infrastructure. Due to these projects, they are able to understand their customers better and, for example, to make more personalised offers. Agility lies in the fact that interviewees perceive both sensing (e.g. of viewing habits) and responding (e.g. by recommending products to buy) to work faster than before.

6.2.3 Relationships

Beyond these performances, the conceptual framework also theorized a number of relationships between the concepts in the framework. This subsection reconceptualises aspects of the findings to show how they represent these relationships.

6.2.3.1 IT in large companies should be seen as digital infrastructures

The first relationship referred to the claim that IT in large companies should be seen as digital infrastructures. It is easy to see how some of the systems observed have infrastructural properties. In the case of analytics, the key IT artefacts are the heterogeneous operational systems used to run Telco's business (e.g. CRM system, customer database). As shown above, these are historically grown and very diverse. Furthermore, some insight was gained into how this growth was not a planned process, but one of evolution, as tools were added and modified over the decades. For example, in the Sales infrastructure, the OneView CRM system has evolved to be the main tool used for processing orders, even though this was not the intended purpose

of the tool. The systems are invisible to most users unless they break down. Thus, they constitute a typical example of digital infrastructures. In the case of OfferMaker, the modifications to these infrastructural systems described in the case study illustrate how such evolution can be influenced when individual users engage with them. The relational character of digital infrastructures becomes clear when looking at some systems that are only perceived as infrastructural in certain contexts. The Analytics digital infrastructure is a good example for this, as it contains the systems used to transmit digital content (e.g. TV) to customers. These are infrastructural in that they are invisible for TV users, but not so for Telco employees using them as part of their work, e.g. to transmit TV. Likewise, the tools providing data for Analytics (e.g. the customer database) are invisible for analytics users, who only see their output on their dashboards, but not for the users entering content into the databases. Thus, while it does not make sense to conceptualize any IT in organizations as digital infrastructures, the concept has specific benefits that recommend it in order to conceptualize historically grown socio-technical assemblages like the ones presented in this study.

6.2.3.2 Organizational agility should be seen as a practice within digital infrastructures

The next relationship claimed in the conceptual framework argued for seeing organizational agility as a practice within digital infrastructures. The performative character of agility has been illustrated above (6.2.2). This view has been adapted from Zheng et al. (2011) and has arguably added to the understanding of organizational agility in this thesis. The shift in focus from agility as a given quantity to the processes in sociotechnical systems described earlier (3.4) helped to illustrate the role of people in the shaping of digital infrastructures. This was shown in the case of OfferMaker, where one "mad genius" (i5) individual was able to create this new tool, thus supporting agility. SalesTool was similarly created as a result of one employee's idea. Moreover, the view of agility as a performance fits well with the concept of digital infrastructures, which, due to their relational nature, emerge in practice. Thus, the best way to explain their evolution is to focus on the practices involved, as is done here by looking at the interactions among their constituent parts.

6.2.3.3 Digital infrastructures enable and constrain organizational agility

Another relationship claimed in the conceptual framework was that digital infrastructures simultaneously enable and constrain organizational agility. Indeed, this dual nature of digital infrastructures can be illustrated using the examples in this case study. Digital infrastructures support agility by their flexibility, as has been illustrated throughout the case study. This has enabled the creation of OfferMaker and SalesTool as new tools on top of existing legacy systems, as well as the analysis of existing transactional data in the Analytics case. These cases also illustrate the historically grown nature of digital infrastructures, which is shown not only in these add-ons, but also in the fact that the installed base of IT seems to have grown rather unsystematically, as evidenced by the findings that Telco uses "every single operating system under the sun" (i39), or that the existing tools have been gradually adapted to fit the needs of Telco ("built on, and built on, and built on since the 1980s" (i6)), even though there was concern they were not suitable in the first place (OneView "was never meant to be used as an order entry system" (i25)). Conversely, digital infrastructures have also constrained agility. This was illustrated by the limitations inherent in the historically grown installed base (which would make it impossible to just install a new system from scratch (i6)), as well as concerns about security (e.g. protecting customer data (i35)) and regulations (e.g. regulatory requirements (i15)).

6.2.3.4 Focus on interactions between IT, information and people

Finally, the conceptual framework claimed that a focus on interactions between IT, information and people would be beneficial. The case study has illustrated how information plays an important role as users shape their digital infrastructures around the flows of information that best support them. At the same time, it is these users who successfully engaged with the digital infrastructures in order to shape them according to their needs. This illustrates Star & Ruhleder's (1996) view of infrastructure as "a fundamentally relational concept [that] becomes infrastructure in relation to organized practices" (p. 4). Thus, it is exactly the interactions described here that enact and create the digital infrastructures described in this chapter.

6.3 Early mechanisms

The following sections present the mechanisms proposed in the various iterations of the analysis process, focusing on three aspects:

- the context that led to proposing the mechanism,
- the retroduction of the mechanism, which describes the mechanisms in detail,
- and a comparison of the mechanisms based on their benefits, limitations and explanatory power. These are summarized in Table 17 (p. 161).

6.3.1 Context

In the retroduction phase of the analysis, the conceptual framework (Chapter 3) served as the starting point for the explanatory theory developed in this chapter. It conceptualized agility as a performance within a digital infrastructure (consisting of IT, people and information) and proposed the following relationships:

- IT in large companies should be seen as digital infrastructures
- Organizational agility should be seen as a practice within digital infrastructures
- Digital infrastructures enable and constrain organizational agility
- Focus on interactions between IT, information and people

Consequently, the initial research questions focused on the benefits of digital infrastructures for organizational agility, and especially on the role of IT in digital infrastructures. From the early stages of the case study, benefits of digital infrastructures emerged. These related to qualities like flexibility, modularity and generativity. Flexibility of IT has been described as a success factor for agility in the literature (e.g. Tallon 2007; Tallon & Pinsonneault 2011). The units of analysis presented in the case study certainly serve as examples for the importance of this. Especially in the cases of OfferMaker and SalesTool, the ability to change infrastructures with relatively little effort was essential for making the changes that led to increased perceived agility. Thus, some evidence was collected that showed how Telco benefited from having a historically grown IT landscape that enabled employees to make some changes in order to increase agility.

The concept of modularity (Yoo et al. 2010) develops this further. The information systems observed in the case study are historically grown assemblages of different systems communicating with each other. Thus, they are loosely coupled. Employees see some of the existing systems as modular (i2). This is an important aspect supporting the instances of generativity and, ultimately, agility perceived by interviewees. In the case of SalesTool, the new tool was added as a layer on top of the existing systems. This was enabled by the fact that the underlying technologies are reasonably standardized. E.g. it was possible to pull out the information from the database in a structured way and re-use much of the code of the existing web shop to create the new tool. Similarly, in the case of OfferMaker, the system was amenable to extensions like this tool and it was possible for product mangers to manipulate information in the existing product database directly, rather than request changes from the IT team. In the Analytics case, information from across the company is collected in a new Hadoop database and presented using web-based dashboards that make the information easy to access and disseminate.

The digital infrastructures in this case study can also be seen as evidence of generativity (Zittrain 2008; Eck et al. 2015) in the information systems analysed. In the cases of OfferMaker and SalesTool, generativity lies in the fact that existing systems enabled and supported new solutions like these tools to be built on top of them. As it is possible to exchange data between the old and the new tools, and to edit this data, it was possible to create OfferMaker and SalesTool as relatively lightweight solutions. Moreover, OfferMaker also increases generativity as it makes it easy to create new offers. In the case of Analytics, generativity lies in the fact that the existing tools (which are producing the data) can end up being used for real-time analysis, as in the example of digital TV. As mentioned above, this supports Yoo's (2013) argument that innovations based on generativity are “distinctly different” (p. 228) from those based on modularity and better able to explain contemporary phenomena.

6.3.2 Retroduction

Based on these qualities of digital infrastructures, the mechanisms of invisibility and tinkering were proposed at this stage. They describe possible processes involving digital infrastructures that may support agility. Invisibility as a quality of infrastructures (following Star & Ruhleder 1996) was proposed to explain how people who

were using digital infrastructures were increasingly unaware that they were interacting with them. In the case of analytics, sales agents were able to make personalized offers to customers in real time using information from the CRM system without being aware of the complex digital infrastructure at work in the background. Interestingly, these processes are similar to processes that have always occurred in businesses (e.g. merchants giving regular customers special offers), but now, they are also within reach of large organizations that may not have the same amount of contact with their customers. In this example, it appears as if the information systems do indeed turn into infrastructures. As Star & Ruhleder (1996) argue, infrastructure is normally invisible unless it breaks. It is interesting that projects like OfferMaker and SalesTool had the same effect on Telco employees – as the tools were less obtrusive, they demanded less of their users' attention. This was illustrated in the case of SalesTool, as employees reported they were advised to look away from the screen in order to be able to focus on their interaction with the customer while using the old OneView tool. With SalesTool, users specifically remarked on how the tool enabled them to just do their job (i30).

The other mechanism proposed at this stage, tinkering, is a phenomenon well described in Information Systems research. Ciborra (1992) defines it as "invention and prototyping by end users (…) together with open experimentation" (p. 288). The case study illustrates how Telco has been building its IT estate into ever more complex digital infrastructures. This has been evident in the cases of SalesTool and OfferMaker, where historically grown assemblages of information systems could not be easily modified, even though they considerably slowed down work processes (i5). However, as there is no central, monolithic system in these cases, this has led to a number of modular systems that enabled tinkering to adapt them to their users' needs. This can be seen as a central principle in all three units of analysis: In the cases of OfferMaker (5.3) and SalesTool (5.4), the new tools started as individual initiatives and were built on top of existing infrastructure to solve a problem that individual end users saw as constraining agility for the wider organization (i5, i23). Thus, the systems remained generative as they enabled new uses that were not part of their original design. The infrastructural character of the tools discussed here, and the flexibility it provides, was critical as it enabled small, but significant changes to these tools, which ensured they remained useful for their users. Even in the case of

Analytics, there is a sense of experimentation and prototyping as the research team comes up with different kinds of analysis to support business users (i35), some of which are then formalized and become part of regular business processes (i22).

It follows therefore that, when planning and designing information systems, companies should encourage qualities like modularity, flexibility and generativity over a central plan and monolithic systems as advocated by traditional information systems development methodologies (e.g. DeMarco 1979). As illustrated in the case study (e.g. around the implementation of Analytics tools), workflows tend to be messy and changing, whereas the tools supporting work are often portfolios of tools selected on the spot (as in the co-existence of SalesTool and OneView). There may even be individual differences in tool use (as with the case of agents using OneView or SalesTool depending on how experienced they are). This builds on concepts discussed above, like Ciborra's (2000) notion of drift or Mathiassen & Sorensen's (2008) concept of portfolios of services employees build in order to support their workflow.

Thus, the view developed at this stage of the analysis was that large, traditional organizations can cultivate their digital infrastructures in order to increase their agility by designing information systems so that they become flexible and open to tinkering as they support the on-going processes of work in the organization. This implied that information systems should be seen as parts of a growing infrastructure and cannot be rationally planned in isolation. Instead, one should look at the evolution of the information system and ways to influence it.

6.3.3 Comparison

The mechanisms of invisibility and tinkering fit the case well but still have limited explanatory power. While they explain how some of the qualities of digital infrastructures can support agility in organizations, it was found they are not general enough to be more broadly applicable. Invisibility is a quality of infrastructures as per the definitions discussed in the literature review, however, it is not clear from the case study whether this in itself can contribute to agility. Tinkering has been observed in all three units of analysis, but again it is unclear whether this alone contributes to agility. Thus, they are seen as relevant aspects of agility, but were not included in the explanatory framework.

6.4 The limits of agility

6.4.1 Context

The findings on generativity were balanced by the insight into the limits of agility in the next iteration of the analysis. It emerged in the case study that interviewees did not see agility as a goal worth achieving unreservedly, as one interviewee put it:

> We aren't a greenfield business, so if you compare us with a new start-up who hasn't got anything in the ground, it's relatively quick for them to go out and buy some product and deliver it. But you know, it's much more complex when you've got a very old business with lots of embedded products and services. (i4)

Consequently, this phase of the analysis focused not only on aspects limiting agility (which have been discussed in the literature), but also on aspects limiting people's desire for agility. Interviewees did not strive for unlimited agility, as they were very aware of the limitations that Telco operates under. They constantly balanced the desire for Telco to be more agile with an awareness of these limitations. Overall, the company can be seen to be in conflict between its employees' desire for agility and the various constraints limiting the agility it can achieve. Table 15 summarizes the aspects mentioned by interviewees as limiting agility.

Aspect	**Quote**
Bureaucracy	"I think like a lot of large companies there's always going to be a degree of bureaucracy" (i4)
Communication	"It is now much more of a two-way conversation and the people that we deal with… are much more open with us and that helps us to anticipate what they want much more." (i3)
Complexity	"you've got so many different operating systems, and they've all got to be patched and upgraded, which means now you've got all the multiple different license costs." (i39)
Cost	"the work that I pulled together over the last six months, it's very well received, and yet there's no money to do a lot of things this year" (i5)
Integration	"there are the fundamental complexities of actually how to integrate new solutions into our business" (i4)
IT capacity	"there are always capacity constraints. There are various components within each release, and we find that there tends to be one component which is overstretched - so even if you have surplus elsewhere, it's a bottleneck for everything." (i7)

Aspect	Quote
Lack of IT systems agility	"So that caused us no end of problems, because our systems are just not agile enough for us to be able to make changes." (i1)
Politics	"There's always internal politics in any company, and the bigger the company, the more likely there is to be internal politics." (i22)
People management issues	"It depends very much on how the objectives are written and how they are crafted but we have sometimes objectives that are written almost around project deliverables. They say "Produce a deliverable". The fact that the individual stops thinking about whether that deliverable is a good idea at all in the first place." (i3)
Priorisation	"identifying the data that we need, and convincing the right people that it makes sense to bring that data in." (i22)
Process	"It's a very, very slow process to get things in the pipeline, to get the software testers to do their work, to get the designers and the developers to do their work, then get it through the test process, then get it approved to release." (i11)
Regulation	"There is an Ofcom requirement to store the emails and Social Media in Oneview – correspondence is documented, emails, letters etc. Advisors are expected to put in notes after every call." (i15)
Resources	"The biggest problem, as ever, is one of resources. There are not enough resources to deliver at the speed that product teams would like to deliver." (i13)
Scale	"It can be frustrating. Because of the sheer size… as companies become bigger and bigger, they tend to become less and less agile." (i6)
Security	"But I'm sure practicalities are - you carry a laptop around with you, and then it's easy to leave it in the luggage rack, isn't it. So we're going to try and avoid that situation by not letting the data go out anywhere, unless it's got pretty strict controls on it." (i22)
Technical skills	"because the teams were pared down so much, there's some fundamental skills missing." (i13)

Table 15 Limits of agility

As illustrated in the findings (Chapter 5), some of these limitations are due to organizational and broader constraints. For example, the size and complexity of Telco as an organization was mentioned by many interviewees (e.g. i39). Likewise, broader aspects like the legal and regulatory frameworks in which Telco operates, were also

common concerns (e.g. i15). However, the nature of the digital infrastructures also brings some constraints: In particular, the historically grown installed base limits the scope of change that can be easily achieved. This was particularly evident in the SalesTool case, where the existing, historically grown sales infrastructure is so deeply ingrained in the workflows that replacing it would be extremely complex and expensive (i33). Similarly, in the case of OfferMaker, there was no easy way to replace the historically grown offer infrastructure (i5). Moreover, digital infrastructures also place requirements in terms of security and data protection that significantly limit the scope for innovation. This was illustrated by the strong concerns of Telco employees for the safety and integrity if their customers' data in the case of Analytics (i22), as illustrated by the fact that some databases are replicated in Hadoop to make sure the analytics efforts could not compromise it (i38).

It is interesting to note that the installed base also emerged as a response to market needs and due to the desire to be agile – for example the motivation for the initial adoption of OneView was to be more agile in customer service. Further changing the existing OneView system would be expensive and risky – given its role in supporting the company's operations – whereas adding layers onto this legacy system (while still running it) was much simpler, with agents able to revert to using OneView if they had any problems.

6.4.2 Retroduction

The finding that people in Telco do not strive for agility unreservedly is interesting. The goal of this phase of the analysis was to propose mechanisms focused on explaining how these limitations can serve to support organizational agility. A mechanism called *bounded agility* was proposed, defined as striving for agility only within the limits set by the digital infrastructures or the organization. This is inspired by the concept of bounded rationality (Simon 1957; Mathiassen & Stage 1992) and is seen as a mindset that supports innovation and risk taking, but within the limits imposed by elements like regulations and risk control. This was then developed into the concept of *bounded generativity*, defined as "striving for generativity only within the limits set by digital infrastructures or the organization" and supported by two conditions (see Figure 10):

- Bounded agility

- The existence of flexible digital infrastructures

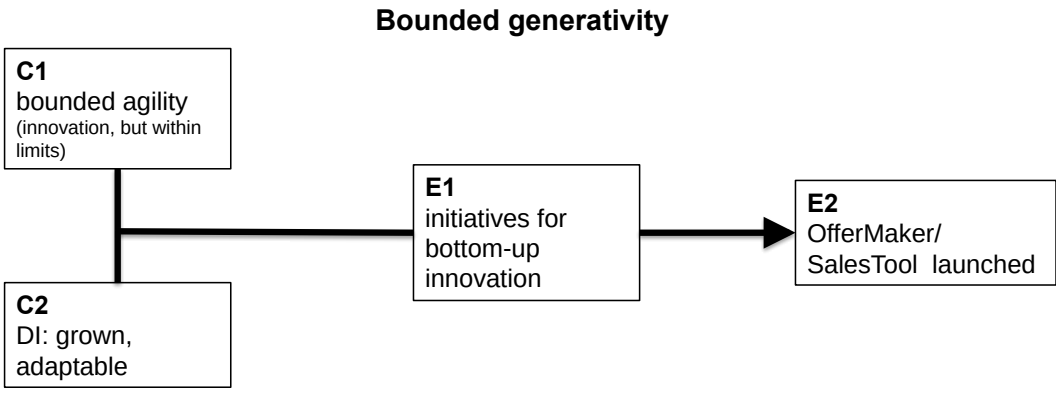

Figure 10 Mechanism: Bounded generativity

These conditions combine to support initiatives for bottom-up innovation, which have enabled individuals to start working on OfferMaker and SalesTool respectively. As illustrated above, agility in these cases is limited by organizational and broader constraints, like the size of the company and regulatory frameworks, but also by the nature of the digital infrastructures, especially the installed base of IT. This leads to behaviour that fits what Simon (1957) calls satisficing: In the case of OfferMaker, there is a sense that employees see the solution as good enough rather than perfect. Even so, there were already some concerns that users ended up creating too many new offers (i26). Likewise in the case of SalesTool, users saw it as "a good way of making a terrible system acceptable" (i32). In the case of Analytics, it was interesting to see how mindful people are of keeping the customer database intact. While this is a very valuable source of data, at the same time its use is limited by regulatory (i22, i37) and legal considerations. Moreover, any loss of data would be fatal, so instead of accessing the database directly for analysis, it was duplicated in the Hadoop database (i34, i37). Thus, the generativity of these digital infrastructures is bounded by aspects of the sociotechnical infrastructures themselves, which was an important quality enabling the successful projects for agility in the case study.

6.4.3 Comparison

The concepts of bounded agility and bounded generativity appear useful and are supported by the findings in each of the three units of analysis. However, in both cases, these proposed mechanisms do not seem to fit well with the concept of mechanisms

used here (Avgerou's "processes composed of entities, actions, and events that produce change"). While there is a notion of processes triggered by entities (users) in both cases, it is unclear whether these do indeed generate agility. It appears that they are better described as aspects of organizational agility than mechanisms. This would also avoid potentially confusing statements like "bounded agility is a generative mechanism for organizational agility". Consequently, neither bounded agility nor bounded generativity was included in the final explanatory framework. However, the concept of attaining an appropriate level of agility for the given situation was retained in the next iterations of the analysis.

6.5 The role of information

6.5.1 Context

The conceptual framework chapter (3.2) has shown that data and information play a key role in information systems as a consequence of digitalization. This was inspired especially by Hanseth & Lyytinen (2010) and their concept of information infrastructures, as well as the recent focus on data in Information Systems research (e.g. Kallinikos 2009). Consequently, the next iteration of the analysis focussed on the role of information in digital infrastructures, especially with regard to organizational agility. As information is here defined as a constituent part of digital infrastructures, the analysis at this stage focused on the role it plays in such infrastructures and the performances of agility observed in the case study. The focus on interactions between IT, information and people proposed in the conceptual framework was developed further in this stage. The interactions concerning information proposed in the conceptual framework (see Table 6, p. 66) can now be analysed:

- Information enters the digital infrastructure when data from within the organization or from the outside world is captured and processed.

The first interaction relates to the way data is transformed into information. This serves to illustrate the definition of information applied in this thesis ("data captured and digitally stored in information systems"). In the case of OfferMaker, offers existed as data in the minds of the product managers whose job it is to define them. These would be written down (thus turned into information) and shared in an unsystematic way with the IT team to be entered into the source code (thus inter-

acting with the digital infrastructure). As one employee (i9) put it, they may sometimes have been written on a piece of paper. With OfferMaker, product managers can now enter the data into the system themselves. In the case of SalesTool, data represents e.g. purchases by Telco customers. It is stored as information in the CRM database. With the new tool, this information is presented in a more precise way to sales agents as they process calls. One goal of the tool was to show them the right information at the right time. In the case of Analytics, transactional data produced by Telco's operational systems (e.g. the web shop or the infrastructure for transmitting digital TV) becomes information as it is fed into the analytics systems (e.g. Hadoop). It can then be selected, processed and presented to its users in the right format.

- Information is stored in IT. IT collects and processes information.
- Information informs the users, who in turn interact with it and modify it.

The other proposed interactions relate to the role of information within digital infrastructures as it is processed and stored by the IT components of the infrastructure and then used by the people within the infrastructure. In the case of OfferMaker, this relates to new offers being created by users (the product managers) in OfferMaker and entered back into the CRM database. Offers are then used throughout the organization (e.g. on the website) and by users like the agents in call centres. In the case of SalesTool, this relates to the information on Telco's customers and products stored in the CRM system. This is used and updated by sales agents in SalesTool, then fed back into the OneView database. There, it serves to inform the sales agents, who get shown the right information at the right time. In the case of Analytics, this relates to the analytics infrastructure storing and processing the information and serving it, e.g. to managers using dashboards. These users would have limited scope to modify the information, but could e.g. make requests for changes to the reports on their dashboards.

6.5.2 Retroduction

A number of mechanisms were proposed in this stage to reflect on the role of information as an element of digital infrastructures. In the three units of analysis presented in the case study, efforts to increase agility were closely tied to improving flows of information within digital infrastructures and the organization. Consequently, a focus on information and its role in the case study led to the proposition of a set of

mechanisms related to information handling. This started out with the metaphor of information as a resource, which illustrates how it can be understood to resemble food in the way it is grown and presented. Based on this, a set of three mechanisms around information use was proposed:

- *Information growing* describes the creation of information, e.g. by simplifying the way data is entered into the digital infrastructure. This can be compared to growing vegetables, which will later serve as food. In the case of OfferMaker, the process of creating offers for the website was slowed down because changes could only be made in the source code by the IT team. A new tool was developed that enables non-technical employees of Telco to make such changes. Thus, agility was enabled as the growing of new information has become significantly easier, as shown in 5.3.3.
- *Information cooking* describes the recombination of existing transactional data to be used for business intelligence. This can be compared to preparing a meal out of raw ingredients. For example, in the case of Analytics, customer viewing data is collected in a separate Hadoop database and serves as the basis for real-time business decisions like which products to offer to a customer. This enables agility as it makes data accessible that could not be used for analysis before, thus enabling new kinds of business insights like the ones described in the findings chapter (5.2.2).
- *Information serving* describes the presentation of information to its users. This can be compared to serving a meal, which depends on choosing the right amount of the right ingredients. In the case of SalesTool, the workflow for employees improved as the tool presents the right information at the right time. Thus, the existing information – which used to be served awkwardly using the old text based database – is now served in a way that is much more supportive of its users' needs. Agility was enabled as the process of supporting customers became faster and more straightforward (see 5.4.3).

Further reflection on the role of information led to the proposal of an overarching generative mechanism of *informatization*, which refers to the activities of converting data into information and managing and sharing information within a digital infrastructure, and, consequently, within the organization.

The aspect of converting data into information is interesting from a critical realist perspective. As discussed in the research design chapter, data, defined as facts of the world, is located in the domain of the actual, whereas information, as processed data, is located in the domain of the empirical, where it represents events. Thus, the information stored in the information systems discussed here not only represents events, but also makes them accessible to analysis. This was particularly evident in the case of Analytics: The business transaction data (e.g. visits to the web shop) refers to actual events of potential customers visiting the shop. The fact that it is now converted into information and stored means it becomes possible to analyse these visits and use them, e.g. for marketing purposes. Through projects like the ones described in the case of Analytics, Telco was able to capture more data than before and store it, which also transferred it from the domain of the actual to the domain of the empirical, opening it up to analysis. Finally, the mechanism of informatization, like all generative mechanisms, is located in the domain of the real.

As illustrated in the examples above, information can be seen as a part of digital infrastructures and its management and sharing (here exemplified by the mechanisms of information growing, cooking and serving) is essential for the functioning of an organization and contributes to its agility. Consequently, companies should appreciate the role of information in digital infrastructures and plan workflows around the capture and processing of information accordingly. These activities correspond to the concepts of sensing and responding in organizational agility, so this focus on informatization will also support agility.

6.5.3 Comparison

The information mechanisms proposed in the fourth iteration (information growing, cooking and serving) are useful to illustrate the role of information in digital infrastructures. They have good explanatory power, as they illustrate the generation of different aspects of organizational agility. Information growing illustrates the importance of creating information and entering it into digital infrastructures. This is a central task in organizations and should be made as simple as possible. Information cooking illustrates how existing transactional data can be used as a resource for business intelligence, thus stressing the importance of such data. Information serving illustrates the importance of improving the workflow for employees by presenting

the right Information at the right time. This illustrates how information is a key element of the daily workflow, and how it plays an important role in supporting it by serving the right information. While these mechanisms are useful, their scope is still limited as they only refer to the generation of one aspect of organizational agility each. The more general mechanism of informatization is useful as it stresses the relevance of information for agility. It can encourage practitioners to focus on the role of information and improve the handling of information, e.g. along the lines outlined in the information mechanisms presented earlier. Thus, it has been included in the explanatory framework. The mechanisms of information growing, cooking and serving are maintained as mechanisms supporting informatization.

In general, this stage of the analysis indicates that information is a central element for both digital infrastructures and agility. The case study has illustrated how it plays a central role in the three units of analysis and the infrastructures associated with them. Considering information as an element of digital infrastructures further helps to conceptualize them as socio-technical systems in organizations and contributes to a better understanding of the interactions in digital infrastructures. Likewise for agility, the case study has shown how in each of the three units of analysis, achieving agility involved a strong element of improving the flow or management of information (as illustrated by the mechanisms of information growing, cooking and serving). The question of whether information is an important aspect for agility in general is beyond the scope of this thesis, but would be interesting to address in future research. Finally, the conceptual differentiation between data (facts of the world) and information (data captured in information systems) proposed here contributes to a clearer insight into some of the processes around digital infrastructures: In this view, one of their functions is to convert data into information, thus making it accessible and useful for the organization. Again, this seems promising for future research as it clearly distinguishes these terms and aligns them to the ontology of critical realism.

6.6 Digital infrastructures as a lens

6.6.1 Context

In the next iteration of the analysis, there was a focus on how people contribute to the digital infrastructures in Telco. An insight was developed from analysing the

infrastructural nature of some of the information systems presented in the case study: Digital infrastructures should be understood as a lens to look at information systems in organizations. Thus, in this phase of the research, the view of digital infrastructures shifted from seeing them as a tool (as implied by the initial research question, "How can digital infrastructures support performances of agility in organizations?") to seeing them as a lens through which to look at existing IT in organizations. The latter view is reflected in the mechanism of *infrastructuralization* here, defined as interpreting the information systems in organizations as digital infrastructures. This was inspired by the tradition of interpretivist Information Systems research (e.g. Ciborra 1996; Walsham 2006), and especially Weick's (1995) concept of sensemaking. Thus, people contribute to agility in these digital infrastructures both by engaging with the grown IT in Telco and shaping it and by interpreting it as digital infrastructures.

6.6.2 Retroduction

This view takes up the notion of sensemaking (Weick 1995) that was identified as a factor of collective agility by Zheng et al. (2011). As Weick puts it, "sensemaking is about the ways people generate what they interpret" (p. 13). The concepts of "information systems" and "digital infrastructures" are here seen as different ways of looking at the same phenomena. The traditional view of systems inside organizations sees them as more static and constrained, as represented by the traditional term 'information systems', which defines systems by their performative functions. The infrastructuralization view advocated here takes a more modular, service based, open perspective on a similar phenomenon, reflecting the change in systems today whereby they are more infrastructural. This thesis argues that organizations commonly focus on the former view, but they would benefit from adopting the latter.

The case study has presented several instances where employees in Telco engaged in such sensemaking activities. For example, there were several incidents when interviewees spoke about the way their IT has historically grown (e.g. "it's just bits added on as it goes", i17). Moreover, it is argued here that the changes brought about in the cases of OfferMaker and SalesTool were only possible because employees interpreted their information systems as digital infrastructures as this enabled them to see them as grown, evolving systems open to such modifications. This enabled them to

engage in the creation of these tools, which were relatively minor additions to the grown infrastructures that nevertheless significantly supported agility. This act of sensemaking enabled employees of Telco to solve the issues around the lack of agility presented in these two cases. At the same time, the changes made to the systems were relatively small and did not endanger the day-to-day functioning of these systems.

Developing further the focus on the interpretations performed by the users of an information system, a mechanism called *agilization* was proposed. This relates to the act of making an organization more agile by cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility for the given situation. Thus, it takes up elements of the mechanisms of informatization and infrastructuralization as well as the notion of bounded agility. The concept of agilization stresses the performative nature of organizational agility and highlights the aspect of sensemaking, the choice by people in the organization to make it more agile. It also takes up the idea of agility as a performance by the users of an information system, as formulated by Zheng et al. (2011). Agilization can include many activities, but in this case, the focus was on the interactions with digital infrastructures, which constitute an important part of these activities. As digital infrastructures are here conceptualized as both enabling and constraining change, it becomes clear that successful agilization involves engaging with, and harnessing, the digital infrastructures the right way. This is illustrated next and summarized in Table 16 (p. 159).

The term 'cultivation' goes back to Ciborra (1997) and has recently been used by Grisot et al. (2014) to describe the development of an information infrastructure:

> A cultivation approach acknowledges the existence of the installed base, and it seeks to address change in an incremental and gradual manner. (…) Overall, three main aspects can be said to characterize a cultivation strategy: process-orientation, user mobilization, and learning. (p. 200)

In this case study, aspects of cultivating digital infrastructures were evident in all units of analysis: for OfferMaker and SalesTool, this relates to the modifying of the historically grown infrastructures. In the case of Analytics, existing systems were interpreted as resources for the new analytics infrastructure. Also a Hadoop database was created to enable real-time analysis of business information. A central goal of

these initiatives in all examples was to improve flows of information. This was illustrated using the examples of faster, easier offer creation (OfferMaker), a new, simple interface enabling faster order processing (SalesTool) and the analysis of transactional data to present information on it in real time (Analytics).

The aspect of attaining an appropriate level of agility for the given situation was also present in each unit of analysis: for OfferMaker, the tool was perceived as increasing agility in the order creation process. Nevertheless, there were limitations due to the grown infrastructure (for example, it does not work for all products yet). Also, some employees were concerned that with the new tool, there may be too many offers now (i24). In the case of SalesTool, there is some evidence that it has accelerated order processing. Partly, this was achieved by presenting limited options to sales agents (thus making it harder to break anything or make mistakes). This tool was also constrained by the historically grown infrastructure, as for example it still needs to coexist with the old OneView tool. In the case of Analytics, the initiatives were seen as increasing agility as they enabled more informed business decisions based on information that would not have been available earlier. This perceived agility was again limited by constraints like concerns around privacy and data security as well as regulatory issues (i22) or organizational concerns (i37).

	OfferMaker	SalesTool	Analytics
Cultivating digital infrastructures	Tinkering, modifying grown infrastructure	Tinkering, modifying grown infrastructure	Interpreting existing systems as resources for new digital infrastructure, creating a new Hadoop database
Minding flows of information	Improve flow of information – here: faster, easier offer creation	Improve flow of information – here: simple interface, faster order processing	Analyze transactional data and present information on it in real time
Attain appropriate level of agility	Higher agility than before – limitations due to grown infrastructure. Concerns that there may be too many offers now.	Faster order processing, limited options (harder to break anything), constrained by grown infrastructure (e.g. co-existence with old OneView tool)	Constrained by concerns around privacy/ data security and regulation

Table 16 Aspects of agilization

Thus, the mechanism of agilization illustrates how, by cultivating digital infrastructures and minding flows of information, companies can attain an appropriate level of agility for a given situation. Referring back to the terms of the conceptual framework, agilization contributes to the creation of change with perceived economy, quality and/ or simplicity.

6.6.3 Comparison

The mechanism of infrastructuralization is useful as it illustrates how existing information systems can be interpreted as digital infrastructures, which can then lead to developing them in a way that strengthens infrastructural qualities like modularity and generativity. Either way, this mechanism has higher explanatory power than the ones discussed above, as it is broader and relates to more general situations. Likewise, the mechanism of agilization is useful as it combines the notions of digital infrastructures and organizational agility, thus illustrating the relevance of digital

infrastructures for agility. Together with informatization (discussed above), these mechanisms were selected as the key elements of the explanatory framework.

6.6.4 Summary

The proposed mechanisms that were presented and compared regarding their explanatory power are summarized in Table 17. Details of the 'comparison' stage of the analysis (summarized here as Benefits, Limitations, and Explanatory power) were discussed in the "Comparison" subsections in this chapter (e.g. 6.3.3).

Mechanism	**Definition**	**Benefits**	**Limitations**	**Explanatory power**
Invisibility	DI increasingly used by people who were not aware that they were interacting with them	Fits with observation of increased invisibility of some DI	One aspect of infrastructures, limited explanatory potential	May support agility, but not very significant
Tinkering	Invention and prototyping by end users, open experimentation	Established concept in IS; observed in 2 of the 3 units of analysis	Limited explanatory potential, unclear if it generates agility	Limited – may be either a generative mechanism or a result of agility
Bounded agility	Striving for agility only within limits set by DI/ organization	Useful concept, fits the observations in all 3 units of analysis	aspect of agility, not a mechanism	Good – stresses relevance of limits of agility
Bounded generativity	Striving for generativity only within limits set by DI/ organization	Useful concept, fits observations in all 3 units of analysis	aspect of agility, not a mechanism	Good – stresses relevance of limits of generativity
Information growing	Simplifying the way data is entered into IS	Useful concepts, explain an aspect of agility each. Each observed in 1 of the 3 units of analysis	Limited scope. Explain generation of an aspect of agility each	Good, but limited scope
Information cooking	Using existing transactional data for business intelligence			
Information serving	Improving workflow by presenting the right information at the right time			

Mechanism	Definition	Benefits	Limitations	Explanatory power
Infrastructuralization	Interpreting the IS in organizations as DI	Useful, stresses relevance of DI for agility	Very general	Good
Informatization	Converting data into information and managing and sharing information within a DI	Useful, stresses relevance of information for agility	Very general	Good
Agilization	Cultivating DI and minding flows of information to attain an appropriate level of agility	Useful, stresses relevance of DI for agility	Very general	Higher level construct – summarizes other mechanisms

Table 17 Proposed mechanisms – overview

Out of these candidate mechanisms, agilization, infrastructuralization and informatization were found to have the highest explanatory power. They make up the explanatory framework proposed here. This is summarized in Figure 9 above (p. 136) and will be elaborated next.

6.7 Explanatory framework

6.7.1 Defining the explanatory framework

In the last iteration of the analysis process, a detailed understanding of the case study emerged, seen through the concept of agility as a performance within digital infrastructures. This is summarized in this section, which presents the explanatory framework and the generative mechanisms that have been developed out of the initial conceptual framework. Finally, the framework is applied to address the research questions.

The explanatory framework uses the same concepts as the conceptual framework presented in Chapter 3, although they have changed somewhat in the course of the analysis. For organizational agility, the main finding was that there is a spectrum of agility as people in organizations will strive for the level of agility they feel is appropriate for the specific situation. For digital infrastructures, it was found that they can be seen as either a tool to build new information systems or as a lens for members of

the organization to look at their existing information systems. In both cases, the role of people is important as they interpret events according to the context.

Finally, a number of mechanisms have been defined in the analysis stage. A central mechanism of agilization (6.6.2) is proposed. This is supported by the mechanisms of infrastructuralization (6.6.2) and informatization (6.5.2). Informatization itself is supported by the mechanisms of information growing, information cooking and information serving. These mechanisms are summarized in Table 18.

Mechanism	**Definition**
Agilization	Cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility
Infrastructuralization	Interpreting the information systems in organizations as digital infrastructures
Informatization	Converting data into information, managing and sharing information within a digital infrastructure
Information growing	Simplifying the way data is entered into information systems
Information cooking	Using existing transactional data for business intelligence
Information serving	Improving workflow by presenting the right Information at the right time

Table 18 Explanatory framework – overview

As critical realism sees the domain of the real as stratified (Mingers 2004b), it makes sense to think of these mechanisms as a hierarchy. Agilization would be the highest-level concept containing, in turn, infrastructuralization and informatization. Informatization, then, can be seen to include other mechanisms like the information mechanisms proposed above.

This framework has a higher level of abstraction and generality than the conceptual framework proposed in Chapter 3. Specifically, the mechanisms proposed here represent examples of the interactions between digital infrastructures and organizational agility. Figure 11 illustrates how this is reflected in the diagram of the conceptual framework (compare this with Figure 4, p. 78). It illustrates aspects of the generative mechanisms defined above and how they may support agility. Specifi-

cally, this includes the role of informatization in shifting the observer's focus towards the processes of converting data into information and managing the flows of information within a digital infrastructure. It also stresses the role of people, who are instrumental in interpreting existing information systems as digital infrastructures, as described by the mechanism of infrastructuralization. At the same time, people are instrumental in cultivating these digital infrastructures, as described by the mechanism of agilization. Finally, the performance of responding is qualified by illustrating the need to do so within the boundaries of an appropriate level of agility.

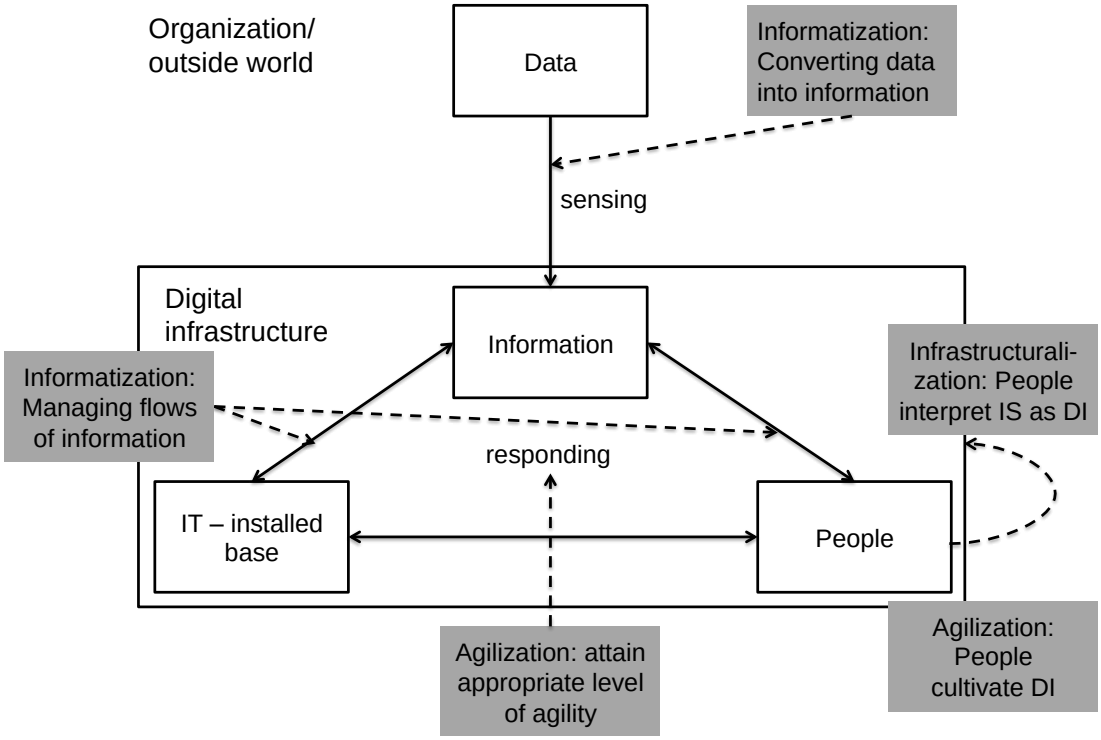

Figure 11 Conceptual framework and mechanisms

From a critical realist perspective, the mechanisms defined here reside in the domain of the real. They cause events in the domain of the actual. The subset of these events that were observed in the case study resides in the domain of the empirical. As the mechanisms are sufficiently general, they should be able to account for other events in the domain of the actual besides the ones researched here, in other words, they are generalizable.

6.7.2 Concretization and contextualization

This subsection looks at how the mechanisms identified above manifest themselves in concrete situations. It focuses on the general mechanisms proposed in the final iteration, i.e. agilization, informatization and infrastructuralization.

The model proposed here sees organizational agility as supported by a mechanism of agilization. This has been defined as "cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility for the given situation". For example, in the context of OfferMaker, agilization lies in the fact that people adapt their digital infrastructure in order to enable non-technical employees to enter new offers into the database. They also improved the flow of information – whereas offers used to be shared informally (sometimes on a piece of paper) and given to the IT team, they are now entered directly into the system by the product managers who create them. It is argued that this includes an element of interpretation, as the "mad genius" employee who created the system refused to accept that there was no easier way to enter offers without exchanging the underlying CRM system. The proposed mechanism contributes to explain events in the other units of analysis. For example, in the case of Analytics, people extended the existing IT infrastructure by adding the Hadoop database which was used for analysing data, so as not to endanger the on-going operations of the business. At the same time, they ensured that transactional data was turned into information and served to the right people in the organization. This mechanism is supported by the conditions of flexible IT, a culture of experimentation and a high level of security and data protection checks (for an overview of mechanisms and their supporting conditions, see Table 19).

Mechanism	**Conditions**
Infrastructuralization	Flexible IT
	Culture of experimentation
	High level of security and data protection checks
Informatization	Flexible IT
	Culture of experimentation
	Mindset of seeing information etc. as elements for a digital infrastructure

Mechanism	Conditions
Agilization	Means of converting data
	Means of storing and processing information
	Mindset of seeing data as a resource that can be converted and used by other systems

Table 19 Mechanisms and conditions

Agilization itself is supported by the mechanisms of infrastructuralization and informatization. Infrastructuralization has been defined as "interpreting the information systems in organizations as digital infrastructures". The case study has shown several instances where Telco employees interpreted their IT estate as a digital infrastructure (without being aware of the concept). For example, in the context of SalesTool, employees assigned a number of qualities to the tool that are usually associated with digital infrastructures. There was a strong sense of it being a grown and evolving tool ("it's just bits added on as it goes", i17). Moreover, it can be described as an instance of an information system becoming invisible. As the tool interferes less with the agents' workflow, they have more time and are better able to focus on talking to the customer. It also illustrates the dual nature of technology discussed above (3.3.4) – for example, employees are in conflict between using SalesTool or the old OneView, which is less user friendly but more powerful. The proposed mechanism contributes to explain events in the other units of analysis, as in the case of Analytics, where the digital infrastructure was created when the disparate elements (e.g. tools that produce the information, tools for analytics and the information itself) were joined together. There is also a strong element of users interpreting the existing information systems as digital infrastructures. For example, the information generated by some tools (e.g. TV viewer logs) was interpreted as a resource for analytics and presented in the various dashboards. Infrastructuralization as a mechanism is supported by the conditions of flexible IT, a culture of experimentation and a mindset of seeing elements like information as parts of a digital infrastructure.

Finally, based on the definition of information as "data captured and digitally stored in information systems" applied here, informatization has been defined as "converting data into information and managing and sharing information within a digital

infrastructure". In the context of Analytics, informatization lies in the fact that transactional data that was previously not used for business analytics can now be used. The proposed mechanism contributes to explain the events in the other units of analysis. For example, in the case of OfferMaker, offers existed as data in the minds of the product managers. As illustrated in the case study, the process of turning them into information has been significantly simplified by the tool as it makes it possible to enter these into a database. This mechanism is supported by the conditions of having the means to convert data, having the means to store and processing information and a mindset of seeing data as a resource that can be converted and used by other systems. Thus, it requires both the tools to convert data and process information and the ability to see opportunities to do so.

6.7.3 Addressing the research questions

Using this framework, the research questions defined in Chapter 3 can now be addressed.

6.7.3.1 RQ1 How do digital infrastructures enable/ constrain performances of agility in organizations?

The first research question aims at explaining the role of digital infrastructures in organizational agility. The early stage of analysis has developed a detailed understanding of the dual nature of digital infrastructures both enabling and constraining agility in organizations. The generative mechanism of agilization illustrates this. It is defined as "making an organization more agile by cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility for the given situation". This summarizes the findings from the case study.

As has been shown, some of the specific qualities of digital infrastructures indeed enable agility. As discussed in subsection 6.3.1, the flexibility of the digital infrastructures in this case study enabled the kind of modifications presented in the cases of OfferMaker and SalesTool. This was illustrated using the concept of modularity, described by Yoo et al.'s (2010, p.727) as "the degree to which a product can be decomposed into components that can be recombined". This is illustrated in the case study by the examples of employees in Telco being able to react quickly to challenges due to the flexible, generative nature of their digital infrastructures. In the cases of SalesTool and OfferMaker, change (and agility) came from the fact that it was

possible to modify the existing, historically grown infrastructures to better support employees' workflows. Such recombinations were indeed a key aspect of the three units of analysis presented in the case study – besides the tools that were added on to existing infrastructures, the case of Analytics also illustrates modularity, as the transactional data from some systems (e.g. customer viewing data) was used as a resource in the new analytics systems (6.2.1). Thus, interpreting existing information systems as digital infrastructures can enable organizational agility as perceived by members of an organization. This may lead to flexible, modular systems that can encourage bottom-up innovation like in the examples of OfferMaker and SalesTool.

On the other hand, digital infrastructures also have a constraining effect on agility. The limitations inherent in the historically grown installed base have been shown in the case study, as well as concerns about security and regulations. For example, in the cases of OfferMaker and SalesTool, the initial issues were due to the installed base of IT, which was not supporting workflows ideally. In OfferMaker, the historically grown tool was not able to keep up with the growing complexity of multi-play offers including telephony, TV and Internet services. In SalesTool, the OneView CRM tool may not have been suitable for its task from the beginning and also suffered from the increasing complexity of products and services offered. In the case of Analytics, it was interesting to see how the constraints came mainly from considerations like legal and regulatory concerns as well as data protection.

The dual nature of the installed base of IT as enabling and constraining change on organizations has been well documented in the literature (Ciborra & Hanseth 1998; Star & Ruhleder 1996; Magnusson & Bygstad 2014). The case study illustrates that the other elements of digital infrastructures, people and information, also contributed to constraining agility in Telco (6.4.1). Some of the issues involving people included people management issues (i3), politics (i22) or the lack of technical skills (i13). Issues around information included sharing information across a large company (i3) as well as the need to present the right information to support employees' workflow (i18). These will be discussed in more detail below.

Moreover, the analysis revealed that such limitations are necessary, as people in Telco are not striving for unrestricted agility. Instead, they strive to achieve the right balance between agility and non-agility. The concept of bounded agility mentioned

above fits with and extends the literature discussed in the earlier chapters. As discussed in the conceptual framework (3.5.2), the dual nature of digital infrastructures aligns well with the concept of bounded rationality (Simon 1957), which postulates that organizations do not make optimal decisions, but satisfice by making good enough decisions. Against this background, it makes sense to postulate bounded agility for companies that need to balance their desire for agility with the need to preserve their business and conform to legal and regulatory standards.

Thus, the answer to RQ1 is that digital infrastructures are an important element of generative mechanisms of organizational agility. They both enable and constrain agility at the same time. They enable agility in organizations due to some of their specific qualities like generativity, which makes modifications like the ones presented in the case study possible, and constrain it due to aspects like the installed base of IT, which potentially slows down work processes and can make it harder to change information systems. This dual nature is reflected in their constituent parts – IT, people and information – who all share this quality of simultaneously enabling and constraining agility. Moreover, due to the performative nature of agility and the relational nature of digital infrastructures, the performances of agility also serve to enact digital infrastructures in return.

6.7.3.2 RQ2 What is the role of people within digital infrastructures in performances of agility?

The second research question asks about the role of people in this process. As illustrated in the analysis they do so in three ways: By shaping the infrastructures and affecting their evolution, by interpreting existing systems as digital infrastructures and by contributing to establish digital infrastructures by enacting performances that serve to establish them. These are briefly summarized here.

Due to the fact that digital infrastructures are complex, historically grown structures (Tilson et al. 2010), shaping them is considerably more difficult than the design of information systems as conceptualized in traditional texts on IS development (waterfall). Yet, as the literature review has shown, much research on organizational agility implies such a rationalist view in which making changes to information systems or organizations is not seen as particularly problematic. Given the dual nature of digital infrastructures outlined in the conceptual framework (Chapter 3), a more

nuanced understanding is emerging here. Any rational planning and design of information systems is limited by the dual nature of digital infrastructures, the grown installed base etc. The case study has shown how it is nevertheless possible to modify such infrastructures, e.g. using strategies like tinkering or cultivating the digital infrastructures for slow change over time.

Evidence of tinkering in the case study has been illustrated in the cases of OfferMaker and SalesTool. In both cases, users of these tools were able to make small changes through invention and prototyping, as posited in Ciborra's definition. On the other hand, there is also evidence of users influencing the longer term evolution of digital infrastructures by cultivating them, e.g. using the elements of process-orientation, user mobilization, and learning as proposed by Grisot et al. (2014). This can be seen in the shaping of the Analytics infrastructure, which was gradually built on top of, and in conjunction with, existing operational systems. Similarly, the development of SalesTool as part of the sales infrastructure could also be seen as an instance of cultivation, as process orientation and user mobilization were key aspects of the design. It will certainly be interesting for future research to develop a more elaborate distinction between these two approaches, and potentially further ways to influence the evolution of digital infrastructures. The information mechanisms proposed above (6.5.2) illustrate how people within Telco shaped their digital infrastructures in order to improve the flow of information, which in turn enabled (what they perceived as) agility.

The other important contribution of people in this model lies in the fact that they create and project interpretations of the world around them. As illustrated above, the mechanism of infrastructuralization explains how people interpret the information systems in organizations as digital infrastructures. Similarly, agilization contains the notion of people in the organization choosing to make it more agile. This act of sensemaking relates to the "collective attitude to deal with uncertainty and ambiguity" observed by Zheng et al. (2011, p.318). This was illustrated in the case study by individual initiatives to re-shape existing information systems, e.g. the "mad genius" employee (i5) who developed OfferMaker on top of the installed base of IT. As argued above, this was based on the fact that this employee interpreted the IT in Telco as grown and amenable to such modifications – as an infrastructure.

Thus, the answer to RQ2 is that people interact with digital infrastructures using strategies like tinkering or cultivating, but they also play an important role in interpreting their digital infrastructures or organizations as something that is agile.

Finally, people have been conceptualized to be the main source of agency in the conceptual framework. As pointed out above (3.4.1), the study focussed on "practices enacted by users as they engage with IT within digital infrastructures". As digital infrastructures are relational and enacted through such performances, it could be argued that the final role of people in this framework is that they constitute the digital infrastructures. It has been argued that material elements like IT can have agency as well. This aspect is left out for the time being, but should be considered in future research.

6.7.3.3 RQ3 What is the role of information within digital infrastructures in performances of agility?

The final research question looks at the role of information. The analysis has illustrated the central character of information in the digital infrastructures analysed here and showed that information is an important element contributing to generativity in digital infrastructures. Handling flows of information the right way can increase generativity, as illustrated in all three units of analysis. For example, in the case of Analytics, the correct handling of information (e.g. collecting data on TV viewing habits and making relevant recommendations for marketing based on it) supports the business. Informatization, defined here as converting data into information and managing and sharing information within a digital infrastructure (6.5.2), has been identified as a generative mechanism contributing towards agility in organizations. The mechanisms of information growing, information cooking and information serving have been proposed to further illustrate this. The relevance of information is also reflected in the mechanism of agilization.

Focussing on information as an element of digital infrastructures has helped to illustrate this relevance. The case study has illustrated how information is a constitutive element of the infrastructures in all units of analysis, for example in the shape of offer information in OfferMaker or website visits in Analytics. The interaction between the elements of digital infrastructures creates and enacts the infrastructure and leads to performances of agility. Organizational agility is a good example to

illustrate the relevance of information for digital infrastructures, as the concept is traditionally defined around the activities of sensing and responding (Overby et al. 2006), both of which relate to the processing of information. The generative mechanism of informatization illustrates the role of information in enabling agility.

Thus, the answer to RQ3 is that information is an aspect supporting generativity in digital infrastructures. It is also an actor that interacts with the other elements, thus helping to create the digital infrastructures. This serves to illustrate the relational character of digital infrastructures proposed in the conceptual framework (Chapter 3). Finally, the way people interact with and manage information within digital infrastructures is a significant aspect for the success of these infrastructures – in this case, their agility. Table 20 summarizes these answers to the research questions and the reasoning that led to them. "ST" stands for SalesTool, "OM" for OfferMaker.

Research question	**Answer**	**Reasons**	**Evidence**
How do DI enable/ constrain performances of agility in organizations?	Specific qualities like generativity vs. the installed base of IT. performances of agility also serve to enact DI in return.	Generativity enabling	Being able to react quickly: ST, OM
		Installed base constraining	Issues initially due to installed base - e.g. OM, ST
What is the role of people within digital infrastructures?	People interact with DI using strategies like tinkering or cultivating, but they also play an important role in interpreting the DI / organization as something that is/ should be agile	Tinkering: way to get grown DI to adapt	Add-ons to grown tools - OM, ST
		Cultivating: way to harness evolution of DI	Influencing longer term evolution - e.g. shaping of Analytics DI
		Interpreting: sensemaking sets frame/ mindset for agility to occur	Employees interpreted IS as DI - grown, evolving, open to modifications: OM, ST
		Enacting DI by human performances – constituting them	People and their performances are a constitutive element of DI in all three units of analysis

Research question	Answer	Reasons	Evidence
What is the role of information within digital infrastructures?	Information is an aspect contributing to generativity in DI. It is also an actor that interacts with the other elements, thus creating/enacting the DI. The way people interact with/ manage information in DI significantly affects the DI's success - in this case, agility	Aspect: handling flows of information the right way increases generativity	All three units of analysis - e.g. Analytics: information handling supports business
		Actor: information is constitutive of DI in all units of analysis	E.g. offer information in OM, website visits in Analytics. Also see information mechanisms
		Interact: see above	

Table 20 Research answers – arguments

6.8 Summary

Through the various iterations of the analysis, it has been shown that digital infrastructures play an important role in performances of agility in organizations as they enable and constrain efforts for agility at the same time. Beyond this, an explanatory framework has been proposed to explain the interactions between digital infrastructures and performances of agility in organizations. It has been shown that people in large organizations do not strive for agility unreservedly. Instead, they aim for bounded agility in well-defined areas that does not put the business at risk.

The analysis has illustrated how people play an important role in digital infrastructures, one the one hand by interacting with them in order to shape them, on the other hand by their activities of sensemaking that can e.g. interpret information systems as digital infrastructures or organizations as agile. Finally, information has been identified as an aspect contributing to generativity, but also an actor within digital infrastructures.

The next chapter will develop this framework into a theory of agility and relate it to the theories that have informed the conceptual framework.

7 Discussion

7.1 Introduction

The previous chapter addressed the research questions by applying the conceptual framework defined earlier to the case study findings. It developed an explanatory framework consisting of generative mechanisms that can enable agility. This chapter develops this framework into a theory of agility and relates it to the theories that have informed the conceptual framework. Thus, it shows how this thesis contributes to the literature on organizational agility and digital infrastructures. The chapter is structured as follows: Section 7.2 outlines a theory of agility as a performance within digital infrastructures based on the concept of agility as a performance and the explanatory framework. Section 7.3 develops the concept of bounded agility that is proposed here to conceptualize the ambiguous relationship between large organizations and agility. Section 7.4 discusses the findings relating to the nature of data and information and discusses how these can contribute to research in Information Systems and critical realism.

7.2 A theory of agility as a performance within digital infrastructures

7.2.1 Outline

The main theoretical contribution of this thesis is a new theory of agility as a performance within digital infrastructures. The theory started from the concept of agility as a performance (Zheng et al. 2011) and extended it by relating it to digital infrastructures. This led to the definition of the explanatory framework containing generative mechanisms explaining how agility is enabled by digital infrastructures. The theory marks a significant shift in the way agility in organizations is conceptualized, as it combines the areas of organizational agility and digital infrastructures, along with a clear focus on performances within these infrastructures.

7.2.2 Agility as a performance in digital infrastructures

A central contribution of this thesis lies in the fact that it applies and develops the concept of agility as a performance. As shown in the literature review, much existing

research conceptualizes agility in static terms, e.g. as a capability. The concept of agility as a performance (Zheng et al. 2011) was adopted here as an alternative view of organizational agility as its focus on the performances by users of an information system adds a welcome alternative conceptualization that enables researchers to consider the role of people in agility as they enact it in a specific context. Moreover, as the consequences of digitalization have not been broadly considered in Information Systems research on organizational agility, this thesis combined the notion of organizational agility with the concept of digital infrastructures, which is itself relational and focused on performances. This led to the theory of agility as a set of performances within digital infrastructures outlined here.

As shown in the conceptual framework (Chapter 3), Zheng et al. (2011) introduce the concept of agility as a performance, thus connecting the field of Information Systems research on organizational agility to the tradition of practice-based research in Orlikowski's (e.g. 2000) tradition. As argued before, this view was adopted in this thesis as it has the potential to shift the focus of research from agility as a given quantity to the interactions in sociotechnical systems, where users enact agility in response to their surroundings. It was also hypothesized that this focus on practices ties in well with the relational character of digital infrastructures. The case for focussing on practices rather than human or technological actors has been made above (3.4.1), based on Orlikowski (2000) and Schatzki et al. (2000). This view has two significant consequences for the way agility in organizations should be conceptualized. Firstly, it stresses the character of organizational agility as a performance. Thus, it is seen as the result of an interaction between users and IT rather than a measurable quantity. Secondly, it illustrates how people acting in this context contribute by interpreting their surroundings in a specific way, stressing the subjective character of agility. This will be elaborated next.

This view of agility as a performance within digital infrastructures contributes to existing research in several ways. The concept by Zheng et al. (2011) was applied and extended, specifically as it is related to the stream of research on digital infrastructures. The notion of performances seems useful to connect this view to the concept of digital infrastructures, which are themselves relational and thus enacted through performances in organizations.

Agility is conceptualized here as a set of performances by the users and designers within a digital infrastructure in order to swiftly react to events in the outside world. Specifically, the performance of responding to change in the outside world was conceptualized as the interactions between IT, information and people within a digital infrastructure. This view has proved useful in this thesis, which started out researching performances within digital infrastructures and ended up identifying mechanisms based on these performances. Infrastructures are seen as enacted by the activities of their members. The proposed mechanism of agilization then relates to the way people within this infrastructure engage with and harness it. This leads to a significantly different concept of organizational agility compared to much of the existing literature (the static definitions of agility seen in much of the literature) that takes into account digital infrastructures as well as performances. Using this conceptualization, agility can be described as a performance that emerges from the interactions among the elements of an infrastructure. Finally, this view also acknowledges the role of people interpreting their surroundings and making sense of them, which has been shown to be an important aspect of these performances in the case study. This was especially visible in the case of the mechanisms of infrastructuralization and agilization, which involve the notion of people interpreting their surroundings, e.g. by interpreting an information system as a digital infrastructure.

7.2.3 Explanatory framework

To better explain how digital infrastructures may support organizational agility, this thesis combined the concept of agility as a performance with the concept of digital infrastructures. It proposed a set of generative mechanisms explaining how agility can be enabled by digital infrastructures. The focus on performances within digital infrastructures, i.e. the interactions between their elements (IT, people and information), led to the explanatory framework derived in the previous chapter. This subsection looks at the framework in more detail, discussing it in relation to existing Information Systems research on organizational agility, and illustrating how it contributes to it.

Agilization combines the ideas of cultivating digital infrastructures (Ciborra 1997; Grisot et al. 2014) and minding flows of information to attain an appropriate level of agility. It addresses some of the issues identified in the literature review (Chapter 2)

and was developed from the conceptual framework that was based on them (Chapter 3). The literature review has shown that much existing Information Systems research on organizational agility conceptualizes it in static terms, e.g. as a capability. This has been criticised as a lack of variety (Salmela et al. 2015). The alternative conceptualization of collective agility as a performance, "an attribute emergent from the day-to-day practices of social actors" by Zheng et al. (2011, p. 305) has been one of the starting points for this thesis and a key element of the conceptual framework. Agilization extends this by the concepts of digital infrastructures, information and attaining an appropriate level of agility, thus summing up the approach taken in this thesis and elaborated in the conceptual framework chapter.

The conceptual framework theorized agility around activities involving information, as sensing is seen to occur when data from within the organization or from the outside world is captured in digital infrastructures (following the definition of information applied in this thesis), while responding is seen to refer to the interaction between the components of the digital infrastructures. This led to the notion of agility as a performance within digital infrastructures, specifically in the interaction between their elements – here defined as IT, information and the people using and designing the IT. As the analysis found that these people play an important part as their members make sense of situations, it emerged that, to a certain degree, it is up to them to interpret an information system as a digital infrastructure, or a part of an organization as agile. This led to the mechanism of agilization, which takes up this notion.

In the context of the case study presented in this thesis, agilization explains how people in Telco interacted with their digital infrastructures, but also how they interpreted situations in order to provide for agility. Thus, the mechanism sums up the way organizational agility has been conceptualized in this thesis. It considers the concept of digital infrastructures as well as the performative character of agility within these infrastructures. Finally, it also reflects on the role of information. This goes significantly beyond the definitions of agility discussed in the literature review and it appears promising to apply this mechanism in other contexts as well.

As a consequence of digitalization, information has been a central element of the conceptual framework. This was due to the fact that, as digitizing has separated

information from a fixed medium for storage and transfer, more flexible, modular information systems are possible (Yoo et al. 2010). This thesis acknowledged this by conceptualizing information as a key element of digital infrastructures. The concept of agility as a performance in digital infrastructures also stresses the relevance of information in agility, as reflected in the mechanism of informatization in this thesis. The difficulties of defining, and distinguishing, the terms of data and information in previous Information Systems research (McKinney & Yoos 2010) were addressed here by the definition of data as facts of the world and information as data processed and stored in information systems. As illustrated in the research design chapter (4.1.2), this aligns with the ontology of critical realism, as data is located in the domain of the actual, whereas information is located in the domain of the empirical.

As information is seen as a constituent part of digital infrastructures in this thesis (following e.g. Hanseth & Lyytinen 2010), it plays an important role in performances of agility, which are seen as the interactions between these elements. This has been illustrated by the fact that the projects presented in the case study were all focussed on improving the way information is managed and shared. The mechanisms of information growing, cooking and serving illustrate this and provide potential to be applied in other contexts. Informatization, converting data into information and managing and sharing information within a digital infrastructure, reflects on the definitions of data and information used here and illustrates how these concepts, defined this way, can be usefully applied. It reflects the increased relevance of data and information as a consequence of digitalization and illustrates the relevance of flows of information within digital infrastructures. In the context of the case study presented in this thesis, informatization explains the role of information for performances of agility within digital infrastructures and the importance of activities around it, like the way it is managed and shared by the people in a digital infrastructure.

This term ‘informatization’ is also used by Kallinikos (2009) to describe “the computational logic by which reality is rendered as information” (p. 183), which is similar to the way it is used here. The difference is that, in this thesis, the focus is on the performance of people deliberately converting data to information rather than on the logic behind it. Another similar concept is informating, as defined by Zuboff (1988).

Whereas in her definition, "[a]ctivities, events and objects are translated into and made visible by information" (p. 10), this thesis assumes it is the data produced by such activities that is translated into information. As used here, the term informatization is very similar to datafication, defined as "unearthing data from material that no one thought held any value" Mayer-Schönberger & Cukier (2013, p. 76). The notion that "datafication is an information technology driven *sense-making* process" (Lycett 2013, p.304, italics in original) fits well with the conceptualization of informatization here.

Thus, this thesis contributes to the literature on digital infrastructures by developing the role of information in such infrastructures. Information is also a concept that has not been used much in existing research in the area of organizational agility (an exception being e.g. Fink & Neumann 2007). Again, it seems promising to apply this mechanism in other contexts.

Finally, infrastructuralization has been defined here as "interpreting the information systems in organizations as digital infrastructures" by the people in the digital infrastructure. This extends the literature on organizational agility by the notion that infrastructures can be seen as results of sensemaking (Weick 1995) or interpretations by the people within them, and that agility can be enabled by interpreting existing systems as infrastructures. As illustrated in the literature review (2.3.6), existing Information Systems literature on organizational agility has been criticised for a lack of variety (Salmela et al. 2015), which was related to the way agility is usually conceptualized (Alvesson & Sandberg 2013). Thus, this thesis contributes to the literature on organizational agility in two ways: Firstly, by introducing the concept of digital infrastructures, and secondly, by showing how these infrastructures can be supported by the sensemaking and interpretations by people in the organization. As illustrated in the case study, it was this interpretation of the IT estate as digital infrastructures (described as taking a more modular, service based, open perspective on IT in the organization – see 6.6.2) that enabled people to tinker with them. This view is supported by the interpretivist epistemology applied in this thesis (4.1.2). Moreover, the importance of sensemaking (Weick 1995) has been illustrated by Zheng et al. (2011), who propose "*Reflective Spontaneity*, making sense by ex-post interpre-

tation and rationalization" (p. 307, italics in original) as one of the paradoxes supporting collective agility.

The notion of sensemaking by people within the infrastructure is also relevant in relation to the literature on digital infrastructures. This stresses the relational nature of digital infrastructures – they are enacted by the performances of people within the infrastructure, including interpretive acts that establish the infrastructures in the first place. As discussed in the literature review, Tilson et al. (2010) acknowledge this relational character of digital infrastructures, but do not elaborate on it in much detail. This was central for the conceptual framework in this thesis, as it is based on the notion of agility as a performance, which ties in very well with the relational character of digital infrastructures. Thus, this thesis contributes to the literature on digital infrastructures by elaborating on their relational character and illustrating how this view can be useful to explain the role of digital infrastructures within organizations.

In the context of the case study presented in this thesis, infrastructuralization explains the role of digital infrastructures in supporting agility, and how this can be the result of acts of sensemaking. This is potentially relevant for other contexts as well, as the notion of defining information systems as digital infrastructures shows them as open and flexible.

7.2.4 Summary

This section has outlined a theory of agility as a performance within digital infrastructures based on the findings discussed in the analysis (Chapter 6). This is based on the concept of agility as a performance, developed into a framework of generative mechanisms explaining how digital infrastructures may enable such agility. This theory marks a significant shift in the way agility in organizations is conceptualized, as it combines the areas of organizational agility and digital infrastructures, along with a clear focus on performances within these infrastructures.

Criticism of the lack of variety in existing Information Systems research on organizational agility (Salmela et al. 2015) has been mentioned throughout this thesis (e.g. 2.3.6), and this has been connected to Alvesson & Sandberg's (2013) advice to focus on root metaphors employed in existing research when defining areas for con-

tribution. One consequence of using the concept of digital infrastructures in research on organizational agility is that it presents the potential for a new root metaphor on agility. Consequently, the concept of agility as a performance has been developed in this thesis as an alternative root metaphor complementing established metaphors like that of agility as a capability (see Table 1, p. 33, for a list of conceptualizations of agility in such research). Thus, it presents an alternative way to conceptualize agility in organizations, which may prove useful for future research.

This theory addresses some of the gaps in the literature and calls for research mentioned at the outset of this thesis, notably Tilson et al.'s (2010, p.753) call for research on digital infrastructures to "strive toward more generalizable models that can provide guidance to designers, managers, and policymakers". This thesis addresses this call by developing a theory that should be generalizable to other contexts. The mechanism of agilization, supported by the mechanisms of informatization and infrastructuralization, is general enough to have potential to be used in other contexts, yet specific enough to focus research on the concepts discussed here, especially digital infrastructures and the flows of information within them. It is based on performances observed in Telco, but it can be reasonably assumed that similar performances will be observable in other contexts as well. Moreover, the elements making up this mechanism – cultivating digital infrastructures, minding flows of information and trying to attain an appropriate level of agility – should turn out useful in other contexts, although future research will have to support this. On the other hand, by focussing on the theoretical constructs introduced in the conceptual framework, these mechanisms have the potential to guide Information Systems research on organizational agility to focus on the same theoretical concepts, which, as the literature review has shown, have not been broadly used before. This section serves to place the explanatory framework in the context of existing research and to point out how it can contribute to this literature.

A consequence of this view would be the recommendation that, instead of adhering to a static view of information systems, as much existing research implies, organizations should adopt the inherent ideas of digital infrastructures, such as their open, modular, extensible character, and apply this when building information systems. This may help them towards achieving agility, as it can lead to actions supporting it.

For example, it can encourage people in organizations to define their existing systems as digital infrastructures, then focus on harnessing them and trying to influence their growth rather than trying to create centralized systems to replace historically grown assemblages. Such a view could also lead to conscious strengthening of infrastructural qualities like flexibility and generativity (within boundaries) in order to increase agility.

The view of agilization proposed here, however, also comes with risks and limitations. Firstly, as it is based on the study of Telco, the question arises to what extent it can be applied to other companies. Specifically, Telco supported cultivation and tinkering in its digital infrastructures due to its company culture and the large amount of technically skilled employees. The role of information was significant and should be so for all companies affected by digitalization. However, a company that is not affected by it (e.g. as it has a strong local monopoly) may find it less relevant. Similarly, agility itself may be less of an issue for such companies. A risk inherent in tinkering is that it keeps on adding to the complexity of the digital infrastructure, increasing the risk that it will eventually stop working reliably. Finally, the ability to provide information in real time is useful, but can potentially also cause issues. In the presentation of information described here through the mechanism of information serving, it is by no means easy to decide which information is actually required at a given time. Managers having access to all of the information on their team may end up focusing too much on improving the metrics produced by such systems and ignoring more urgent issues. After all, it has been argued that "not everything that can be counted counts, and not everything that counts can be counted" (Cameron 1963, p.13).

7.3 Bounded agility

7.3.1 Concept and relation to literature

Beside the theory of agility outlined in the previous section, the second central result of this thesis is the concept of bounded agility. While this is part of the theory developed in the previous section, it is worth elaborating on and putting into context.

Bounded agility is defined here as striving for agility only within the limits set by the digital infrastructures or the organization. Agility is seen as bounded in degree and in

scope: firstly, the case study has shown that people in Telco do not strive for agility unreservedly, but that their desire to be agile is bounded by a number of limiting factors within the digital infrastructures. Such limitations have been illustrated throughout the case study (see Table 15, p. 148). They will be discussed in more detail here, with a focus on the dual nature of digital infrastructures, which illustrates how their constituent parts both enable and constrain agility. Secondly, agility in Telco occurred in small pockets within the organization, so the overall running of the business was not jeopardized. This is illustrated here using the metaphor of water, which shows how frozen, solid parts of an organization can be un-frozen to achieve a small pocket of agility. The concept of bounded agility enables a more balanced view of agility and its limitations, which is significantly different from both the received concept of organizational agility and the related concept of ambidexterity.

7.3.2 The dual nature of digital infrastructures

The relevance of looking at the appropriate degree of agility can be illustrated by looking at the existing literature on organizational agility, which usually sees it as unquestionably desirable. In fact, papers reviewing the literature on organizational agility barely consider this question. For Overby et al. (2006, p.120), "enterprise agility (…) is an important determinant of firm success", while Salmela et al. (2015, p.i) see it as "both difficult and critical for Information Systems organizations" – although they do point out that this depends on the type of industry as they focus on "volatile industries" (p. 1). The concept of bounded agility reflects on the needs of companies to balance agility so as not to endanger their on-going business. This is especially relevant for large companies, as they tend to have more historically grown processes (and digital infrastructures) than start-ups and thus need to be more mindful of the limits of agility.

The limits of agility can be illustrated using the concept of the dual nature of digital infrastructures. The dual nature of technology (Hanseth & Lyytinen 2010; Magnusson & Bygstad 2014) as both enabling and constraining organizational agility has been one of the starting points of this thesis, as reflected in the conceptual framework. The case study illustrated this relationship and cast some light on the roles of the other elements of digital infrastructures, namely people and information. Constraints are caused by the same elements of digital infrastructures that also support

their generativity. Thus, the dual nature of digital infrastructures can be outlined around the elements of IT, people and information.

The dual role of IT is visible in all three cases, which are essentially about people engaging with a historically grown installed base in order to adapt it to their needs. In particular, the installed base limits the scope of change that can be easily achieved. Moreover, the digital infrastructure also places requirements in terms of security and data protection that significantly limit the scope for innovation (e.g. compared to a startup). It was interesting to consider how this installed base also emerged in an existing competitive environment as an agile response to market needs – for example the motivation for the initial adoption of OneView was to be more agile in customer service. Further changing the existing OneView system would be expensive and risky – given its role in supporting the company – whereas adding layers onto this legacy system (while still running it) was much simpler, with agents able to regress into using OneView if they had any problems. On the other hand, the digital infrastructures in the cases presented here enabled a certain level of agility and change. The historically grown installed base affords the possibility for users and developers to shape its growth and evolution. In these cases, OfferMaker and SalesTool were added to the digital infrastructures retrospectively and improved the way these infrastructures work. One might imagine however that these new tools over time become problematic – inhibiting generativity in some way in the future.

The dual role of people relates to the fact that people within a digital infrastructure can both initiate and impede change. While the changes described in the case study were initiated by (often small numbers of) people within the digital infrastructure, there were also instances of people and communities impeding processes. Besides the effects of bureaucracy in a large organization, which were only mentioned in passing here, there were also issues around communicating the innovations brought by some of the projects here. This was particularly visible in the case of Analytics, where interviewees mentioned it could be hard to convince people of the benefit of their experiments in analytics (i35) and spread knowledge of the new tools within Telco (i39). Likewise, in the case of SalesTool, productivity went down initially as its users did not trust the tool to guide them through the sales process reliably (i20).

Similarly, the dual role of information relates to the fact that information can both enable and constrain agility. Information is at the heart of the cases discussed here and thus plays a significant role in enabling them. As the information mechanisms identified in the case study illustrate, managing the flow of information well can support agility considerably. Yet at the same time information, and concerns about it, has also been a constraining element in these cases. This was evident in the case of Analytics, when one of the challenges interviewees commented on was the difficulty of spreading the knowledge about possible ways to analyse data in a large company (i39). In the other cases, the entering (OfferMaker) and display (SalesTool) of information caused the issues that led to these projects in the first place. Finally, even after these tools were implemented, ambiguities remain, for example around the question what products OfferMaker can be used with (i2) or whether a sales agent should use OneView of SalesTool in a specific instance (i30, i32).

7.3.3 Water metaphor

The question of the scope of agility relates to the issue of how to combine innovative and disruptive projects with the on-going running of the firm. As pointed out in the literature review (2.2.4), some of these concerns are addressed by the well-established concept of ambidexterity, "[t]he ability to simultaneously pursue both incremental and discontinuous innovation" (Tushman & O'Reilly 1996, p.24). It shares the notion of balancing discontinuous innovation (often called exploration) with the need to preserve the on-going operations of a business (exploitation). Ambidexterity has large appeal among practitioners, as evidenced by the concept of bimodal IT strategy. This is defined by Gartner (2016) as "the practice of managing two separate but coherent styles of work: one focused on predictability; the other on exploration". This approach is advocated in one of the company's research reports:

> Effective IT execution often lacks urgency – and commitment to bearing the costs, and managing the demands, that an increase in speed and agility would bring. With bimodal IT, CIOs can overcome this inertia, help their departments meet the digital challenge, and ultimately bring the enterprise along. (Mesaglio & Mingay 2014)

As discussed in the literature review, ambidexterity has been developed into the concepts of structural ambidexterity, where separate teams work on such innovative activities, and contextual ambidexterity that is built into the organization as individu-

als can make their own choices (Birkinshaw & Gibson 2004). Yet the former could give the impression that innovation is entirely separate from the overall running of the company, whereas the latter carries the risk of agility being prioritised over the running of the business. The concept of bounded agility, as proposed here, takes the notion of agility occurring as part of the operations of an entire organization (rather than a separate team) from contextual ambidexterity, but balances it with the consideration that people in the organization will not strive for a level of agility that would be so high that it could endanger the operations. Moreover, agility is seen as constrained to small pockets of the organization. While ambidexterity and the concept of bi-modal IT strategy appear to amount to splitting the IT department into two parts, concerned with exploitation and exploration respectively, the view outlined here illustrates that agility should be a concern of the overall organization, but should be limited in scale and scope so as not to endanger the on-going running of the business.

As the case study developed the notion of people within Telco striving for the right level of agility (bounded agility), the metaphor of water can be used to illustrate this. Specifically, the states of water (frozen, liquid, gas) can be related to organizational change. The existing, grown digital infrastructures in Telco can be seen as ossified, frozen systems. Following the theory of punctuated equilibrium (Lewin 1947), it is claimed here that the digital infrastructure needs to be unfrozen, then changed and frozen again. In fact, the metaphor of freezing can be developed as it serves well to illustrate the different states of agility.

In a frozen organization, no change is possible. This is equivalent to ice, in which molecules are fixed and cannot move. On the one hand, this would represent a non-agile organization. On the other hand, the case study has shown the reasons why agility in large organizations needs to be bounded. In practice, it can be assumed that this will be the normal status in most companies, as they have to balance agility with the concerns of running their on-going operations.

A liquid organization (or part of an organization) is in the state described by Lewin as punctuated equilibrium. Change becomes possible, but only within certain boundaries. This relates well to the atomic model, where molecules in a liquid can move, but only within given limits. This would represent an organization with bounded

agility. Moreover, as in the case of Telco, this liquidity is a temporary state and only happens in small pockets of the organization where employees feel the need to increase agility. After the modifications to the digital infrastructures discussed in the case study, the systems went back to more stable (solid) states. Thus, as in Lewin's concept, the systems are re-frozen after change is achieved.

Continuing the water metaphor, it would be possible to imagine a gaseous organization – this would be one with unlimited agility, in which change is not checked by any boundaries. This is similar to molecules in a gas (e.g. water as steam), which can move freely. Companies will have different levels of agility, based on factors like their market position and the constraints towards agility. This could be used to describe start-up companies in their early stages, where pivoting can occur as the company changes its entire business model (Teece et al. 2016). This concept has found broad acclaim as part of the concept of the lean startup (Ries 2011). Yet in practice, most companies would avoid such a level of agility and it is hard to imagine a truly gaseous company, as the on-going change would make the running of a business impossible. The concept is interesting from a theoretical perspective, however, as it illustrates the limits of agility, which are a central finding of this thesis. It also illustrates how unlimited agility would be dangerous in the real world.

7.3.4 Summary

This thesis proposes the concept of bounded agility, which can be placed between the traditional view of agility and the concept of ambidexterity. It sees agility as bounded in degree and in scope, thus extending the literature by the notion of the limits of agility. On the other hand, it does not see such activities as separate from the on-going running of a business, as ambidexterity seems to imply. Bounded agility occurs within boundaries set by the organization and within small areas of the organization. In these, there is a high degree of agility for a limited time, enabling significant change before they return to a stable state. Thus, it complements prior research on ambidexterity as it suggests that agility is a mechanism of greater complexity than implied by the extremes of structural or contextual ambidexterity. As the case study has shown, the situation in Telco (and presumably, in similar large companies) is more complex and nuanced than suggested by such concepts. While agility is desired, this is always balanced with a need to reign in agility in accordance with

constraining elements. It is assumed that this is less of an issue in smaller companies, especially start-ups. The impression that emerges from this is that there is an optimum degree of agility for each organization.

7.4 Data and information in critical realism

An interesting side aspect of this thesis lies in the way it conceptualizes data and information. This subsection compares this view to established views on these concepts, relates it to the ontology of critical realism and outlines how this could be developed in the future.

As shown in the literature review, the term 'information' is often used unsystematically in Information Systems research (McKinney & Yoos 2010). This thesis adds an alternative to the received views of data as synonymous to information (called the token view of information by McKinney & Yoos) and data as raw information (as used by Kettinger & Li (2010) and many researchers in the field), by seeing data as facts of the world and information as data stored and processed in information systems (see 3.3.3). This view (following Checkland & Holwell (1998)) was useful in this thesis, as it allows distinguishing between the raw facts accessed by employees of Telco (e.g. transactional data from the digital television platform, or website visitors) and the way they are processed and stored as information – which was a central element of each of the three units of analysis presented in the case study, for example in the case of Analytics (5.2) when existing transactional data was transferred to a separate database in order to be made available for real time analysis. As shown in the analysis chapter (6.5.2), converting data into information not only represents events, but also makes them accessible to analysis. As Telco was able to capture more data and store it, it simultaneously opened it up to analysis. The importance of information as an element of both digital infrastructures (3.3.3) and agility (6.5) has been illustrated above and summed up in the mechanism of informatization, which in turn supports organizational agility.

Moreover, this view aligns well with the ontology of critical realism. This section discusses how it relates to existing research in the areas of critical realism and outlines its potential for future work. A revisiting of the stratified ontology of critical realism (see Figure 5, p. 84) will help to illustrate how the conceptualization of data

and information has supported the analysis in this thesis. Seeing data as located in the domain of the actual makes it not only conceptually, but also ontologically different from information, which is located in the domain of the empirical (4.1.2). As data is stored in information systems, it becomes information in the domain of the empirical, where it represents the events that are of interest to researchers. Thus, it not only represents these events, but also makes them accessible to analysis. As Telco captured more data, it extended the domain of the empirical as it made it possible to analyse these data (which used to be located in the domain of the actual and were not observed). Thus, it is argued that events in the domain of the actual usually create a data trail and that information systems are created to capture this data, turn it into information and manage and manipulate this information.

The concept of big data has been mentioned in the conceptual framework (3.2.2). Applying the view outlined here to the phenomenon of big data, and the analysis of such data, reveals a useful way of explaining the appeal of such analyses. In this view, the appeal of big data technologies would be that they can extend the scope of the domain of the empirical – as more and more data can be captured from the domain of the actual, big data tools turn this into accessible and useful information. Thus, one of the key tasks of information systems in organizations can be described as collecting data and transferring it into information, thus opening it up to analysis. This can also be described as a consequence of digitalization – as has been outlined above (3.2.2), the role of information in the context of information systems can increase in significance as it gains relevance as an actor. As digitalization separates information from a fixed medium for storage, it makes it more readily available for such analysis. In this context, it is interesting to note that while such approaches can extend the domain of the empirical, they do not by themselves increase our knowledge of the domain of the actual. Consequently, explanatory research still needs to apply analysis methods like retroduction (as used in this thesis) in order to identify the generative mechanisms that cause the events in the domain of the actual that big data has made visible. It remains to be seen how useful this view of data and information will be for future research. Nevertheless, the current usage in Information Systems research appears unsatisfactory as there is no clear distinction between these central terms. In this context, it appears useful to consider alternative conceptualizations like the one introduced here. As information plays a central role in the

modern bureaucratic organization (Yates (1989), see 3.3.2), this understanding of the concept has the potential to be of interest to researchers of organizations in general.

7.5 Summary

This chapter has developed the findings of this thesis into a theory of agility as a performance within digital infrastructures and related them to the theories that contributed to the conceptual framework at the outset of the thesis. Its main contribution is the theory of agility outlined in section 7.2. This includes an elaborated view of agility as a performance, illustrated using the concept of digital infrastructures, and the generative mechanisms identified in the explanatory framework. The combination of organizational agility with the concept of digital infrastructures provides interesting insights into both areas. Moreover, the concept of bounded agility provides an interesting new concept that can clarify some of the issues around the concepts of organizational agility and ambidexterity. It serves to illustrate the limits of agility and can be useful to remind practitioners to balance their desire for agility with the needs of running a business. Finally, the view of data as facts of the world and information as processed data can be useful for future research.

Yoo's (2013, p.231) call for research that fosters "a more precise and nuanced understanding of the nature of digital technology that enables and constrains activities that produce generative innovations" is addressed in this thesis by conceptualizing information systems in a large company as digital infrastructures enacted by their users. This enables a better understanding of the dual nature of digital infrastructures, which are both enabling and constraining change. This has been of central interest for this thesis, as RQ1 specifically asked how digital infrastructures enable and constrain performances of agility in organizations. The analysis has illustrated how they do so due to some of their specific qualities. Moreover, the dual nature of IT, people and information defined in this chapter serves to illustrate how each element of digital infrastructures plays a similarly ambiguous role.

The thesis also provides insights into the way digital infrastructures work by illustrating the role of the interactions between IT, people and information within them. The focus on performances stresses the relevance of sensemaking, as used in the concept of infrastructuralization. This adds to the understanding of how people within the

infrastructure make sense of it and interpret it, thus creating notions like “agility” in the first place. The case study illustrated how people can interpret information systems as digital infrastructures as part of their sensemaking activities. The framework proposed in this thesis is useful as it reflects on the role of digitalization, which is likely to affect more sectors in the future (Giddens 2015).

The next chapter will summarize this thesis and its contributions, and will discuss possibilities for future research.

8 Conclusion

8.1 Introduction

The previous chapter developed the theoretical contributions of this thesis and discussed how they relate to existing research. This chapter summarizes the findings, discusses contributions to theory and practice more generally and outlines possibilities for future research. The chapter is structured as follows: Section 8.2 summarizes the thesis. Based on the three main theoretical contributions developed in the previous chapter, three areas for future work can be defined. These are presented in section 8.3. This is followed by section 8.4, which puts the findings in the context of on-going debates in the wider area of Information Systems research. The following sections outline potential methodological (8.5) and practical (8.6) contributions. The thesis ends with a section (8.7) considering the limitations of this research.

8.2 Overview of the research

The thesis started from the concept of organizational agility, which has met with broad interest from both practitioners and researchers of information systems. Practical interest is illustrated by the fact that it has been among the top 3 concerns of international senior IT executives for years (Luftman et al. 2012; Luftman et al. 2013; Luftman et al. 2015) as companies struggle with ever increasing competitive pressure due to globalization and digitalization. Theoretically, the topic was located in the field of research on Information Systems strategy and it was pointed out how the phenomenon of digitalization has led to shifts in this area that are not yet broadly reflected in the literature on organizational agility. Consequently, the concept of digital infrastructures was proposed to conceptualize the information systems involved with organizational agility.

The review of the literature (Chapter 2) located organizational agility within the field of Information Systems strategy research. Within this, organizational agility is a well-established area of research and existing research has contributed much to develop an understanding of the concept and identify factors supporting agility. However, the field has been criticised for a lack of variety. In particular, it was found

that most research follows a positivist epistemology, which leads to static conceptualizations of agility, e.g. as a capability. Some recent research goes beyond that, notably Zheng et al. (2011), who conceptualize agility as a collective performance – a view that has been adapted in this thesis. Furthermore, the argument was made that, due to digitalization and its consequences, it is useful to introduce the concept of digital infrastructures into this area of research. A review of the literature on digital infrastructures showed that there is a solid and growing body of research, yet much of it is focussed on the areas where the concept originated, like mobile communications or the Internet. Thus, a further area of contribution identified was to add to the research on the use of digital infrastructures in traditional, large companies. The initial research question was "how can digital infrastructures support performances of agility in organizations?"

Based on these themes, a conceptual framework for addressing the research question was defined (Chapter 3). This combines the strands of research on organizational agility and digital infrastructures as it sees agility as a performance within such infrastructures. Digital infrastructures were conceptualized to consist of the installed base of IT, the people interacting with it, and information. The notion of information as part of infrastructures goes beyond Tilson et al.'s (2010) conceptualization, but was outlined by Hanseth & Lyytinen (2010), who speak of information infrastructures. Organizational agility was conceptualized as a set of performances by the users and designers within a digital infrastructure in order to swiftly react to changes to events in the outside world. These performances are seen to consist of sensing, in which data from within the organization or from the outside world is captured in the digital infrastructure, and responding, in which the components of the digital infrastructure interact with each other to adapt it to the demands of the outside world. This led to a rephrasing of the original research question as "how do digital infrastructures enable/ constrain performances of agility in organizations?", as well as additional research questions on the role of people and information within digital infrastructures in performances of agility.

The discussion on how to turn these research questions into a research design (Chapter 4) started by arguing for a critical realist ontology, as it supports explanatory research aimed at achieving generalizable findings and its stratified ontology fits

well with the concept of digital infrastructures. This was combined with an interpretivist epistemology, as the interpretation of sociotechnical processes is central to the analysis. Consequently, a case study was found to be a suitable methodology to address the research question. Data was collected using interviews and observations as well as some documents. Telco was selected as the research site as it is a typical case of a large organization that has grown historically and now has to compete against smaller competitors whom their employees see as being more agile. Data analysis followed the general method of analysing qualitative data outlined by Miles & Huberman (1994), enhanced by some elements focussed on thematic analysis. It finally focussed on identifying generative mechanisms for organizational agility in digital infrastructures.

The findings from the case study were summarized in Chapter 5. They showed that Telco employees do not see the company as agile overall. Nevertheless, they identified several projects which they regarded as agile. Three of these – Analytics, OfferMaker and SalesTool – were presented in detail. While the historically grown digital infrastructures constrained agility in these cases, the people building and using them were able to successfully engage with them in order to achieve agility. This was balanced with the need to preserve the digital infrastructures, as people generally did not strive for agility unreservedly.

The analysis (Chapter 6) illustrated the iterative process by which generative mechanisms were proposed, and the explanatory framework that was derived through this process. In particular, the view of digital infrastructures shifted from seeing them as a tool to seeing them as a lens through which to look at existing IT in organizations. The explanatory framework introduced the central mechanism of agilization, defined as "cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility". This is supported by the mechanisms of infrastructuralization (interpreting the information systems in an organization as digital infrastructures) and informatization (converting data into information and managing and sharing information within a digital infrastructure). Informatization itself is supported by the mechanisms of information growing, information cooking and information serving.

The discussion (Chapter 7) developed this framework into a theory of organizational agility in digital infrastructures, relating it to the theories that have informed the conceptual framework. Its main contributions lie in the generative mechanisms collected in the explanatory framework and its conceptualization of organizational agility. This includes an elaborated view of agility as a performance, illustrated using the concept of digital infrastructures, and the concept of bounded agility. The combination of the concepts of organizational agility and digital infrastructures provides interesting insights into both areas. Conceptualizing information systems in a large company as digital infrastructures enacted by their users enabled a better understanding of the dual nature of digital infrastructures, which are both enabling and constraining change. Bounded agility serves to illustrate this dual nature of digital infrastructures. Agility is seen here as bounded in degree (not every organization will strive for unlimited agility) and in scope (agility should occur in temporally unfrozen parts of the organization). This can be useful to remind practitioners to balance their desire for agility with the needs of running a business. As a third theoretical contribution, the distinction between data as facts of the world and information as processed data was proposed. As illustrated above, this has some appeal within the critical realist ontology as it maps well to the stratified view of reality proposed there.

8.3 Theoretical contributions and plans for further research

8.3.1 Introduction

This thesis should be seen as a first step towards a programme to research agility in digital infrastructures. At the end of the thesis, it is useful to consider how this programme might be developed. The contributions of this thesis to the area of research it addressed have been discussed in detail in Chapter 7. This section will sum up the contributions, including those that go beyond the immediate research area, and outline plans for future research.

A key element of a future research programme will be digitalization and its consequences, which leads to a focus on conceptualizing information systems as digital infrastructures. This lens has provided useful insights in this thesis, so it seems promising to develop it further and apply it to other areas. This will also include a focus

on the role of information in digital infrastructures. As pointed out in the discussion (7.4), critical realism has turned out to be useful for conceptualizing such socio-technical phenomena as the domain of the real can be seen as containing digital infrastructures and the generative mechanisms acting on them.

Thus the combination of practice based research, digital infrastructures and critical realism appears to be a strong foundation for conducting Information Systems research in the tradition of the social sciences. More specifically, the areas of contribution of this thesis can be developed into publications elaborating on these ideas. These will be outlined next.

8.3.2 Theory of agility

The theory of agility as a performance within digital infrastructures developed in the previous chapter has been described as the main theoretical contribution of this thesis. The proposed mechanism of agilization can be used to describe efforts to enable agility in an organization with a focus on the concepts used in this thesis. The theory adds the concept of digital infrastructures to the literature on organizational agility and extends the literature on agility as a performance by conceptualizing agility as a performance in such infrastructures.

This thesis supports the view of agility as a collective performance, which was shown to be a viable alternative to the predominant view of agility as a capability. The concept of agility as a performance has not been used broadly. This thesis contributes to the literature by applying the concept in the new context of a large company. It also relates it to digital infrastructures, which are defined as relational. There seems to be potential to further develop this relationship in future research. This view of agility was extended in this thesis by adopting a critical realist ontology: The performance of agility must be analysed indirectly through people's reports on it and is contingently caused by generative mechanisms. A focus on uncovering such causal mechanisms can lead to research results that can be more broadly generalized (Avgerou 2013; McGrath 2013).

The theory of agility as a performance within digital infrastructures developed in this thesis contributes to the area of organizational agility research (e.g. Sambamurthy et al. 2003; Mathiassen & Pries-Heje 2006; Roberts & Grover 2012). At the same time,

applying the concept of digital infrastructures in traditional, large companies takes up Tilson et al.'s (2010) broad call for research aimed at a better understanding of the ways in which infrastructural change shapes information systems development. The theory developed in this thesis should be developed further and applied to other contexts. As discussed, one way to do this would be through a case survey (Henfridsson & Bygstad 2013). This could shed some more light on the question of how contingent the framework is on the specific conditions within Telco. This would also contribute to the wider area of Information Systems strategy research, which has acknowledged the usefulness of the infrastructure concept (Galliers 2011), but not yet applied it broadly.

8.3.3 Bounded agility

Moreover, this thesis developed the concept of bounded agility, defined as "striving for agility only within the limits set by the digital infrastructures or the organization". Agility is seen as bounded in degree and in scope: The desire by people in Telco to be agile is bounded by limiting factors within the digital infrastructures (degree). Also, agility occurred in small pockets within Telco (scope), so the overall running of the business was not jeopardized.

As illustrated at the beginning of this thesis, there is broad interest in the concept of agility among practitioners and researchers. Little was found in the literature to mitigate this, as research generally does not question the usefulness of agility. The concept of bounded agility can be helpful in this context as it enables practitioners to consider organizational agility from a more balanced perspective, by weighing it against stability and the on-going operations of the business and considering its boundaries in degree and in scope. As the literature on organizational agility generally does not consider such limits, but presents it as universally desirable (Overby et al. 2006; Salmela et al. 2015), the concept of bounded agility provides a necessary corrective (see 7.3). It is related to the established concept of ambidexterity, but adds the notion of striving for the right level of agility. This has been illustrated using the notion of the dual nature of IT, information and people as well as the water metaphor, which describes organizations as either frozen, liquid or gaseous according to their agility and argues for a temporary unfreezing of small parts of the organizations

to create pockets of agility. Based on the findings of the case study, it would be useful to develop this into a publication aimed at practitioners.

8.3.4 Data and information in critical realism

Given the centrality of these terms for the field, it seems important to come up with definitions that clearly separate ‘data’ from ‘information’, and to use them consistently. The view of information and data outlined here seems promising as it clearly distinguishes these terms and aligns them to the ontology of critical realism. It sees data as facts of the world and information as data stored and processed in information systems. This has turned out useful for the analysis, as it has led to the mechanism of informatization, which refers to the conversion of data to information. Following this view, information systems can be seen as efforts to capture “the facts of the world” from the domain of the actual and store them (in the domain of the empirical) in order to make them accessible for analysis. This would apply to e.g. management information systems capturing real-time production data and turning it into information to present in a dashboard, but also to the “quantified self” movement (Shih et al. 2015), where individuals gain insight into their habits, e.g. by counting their daily steps (data) and storing them as information in web-based information systems in order to analyse and share it.

As illustrated above, it might be worth developing this further, as the field of Information Systems would benefit from having clear definitions of these central terms. Following (McKinney & Yoos 2010), it would be possible to conduct a similar study on the use of the term ‘data’ in Information Systems research. Moreover, as the definitions developed in this thesis align well with the stratified ontology of critical realism, such research might be interesting for the community of researchers following this ontology.

8.4 Contributions to the field of Information Systems

As pointed out in the literature review, this research is located in the area of Information Systems strategy research. Beyond the contributions listed so far, it also relates to, and participates in, some of the wider discussions going on in the field. This is illustrated next.

8.4.1 Digitalization and its consequences

This thesis argued that Information Systems research in general, and research on organizational agility in particular, would benefit from a stronger focus on digitalization. Digitalization was an important starting point for this thesis, which aimed to understand the changes it has brought to Telco, seen as an example of similar changes to the areas of organizational agility in large companies. Thus, this thesis can also be read as a study on digitalization and how it increasingly affects areas of Information Systems research not usually associated with it. Digitalization has brought significant change to many areas of life and business (Sambamurthy et al. 2003; Tilson et al. 2010), which, as the literature review has shown, have not yet been broadly reflected in Information Systems research on organizational agility. It is therefore interesting to reflect some more on its role in Information Systems research.

Addressing the call by Yoo (2013, p.228) for research to "account for the changes brought by digitalization, and build new theoretical frameworks to guide efforts to organize generative innovations", this thesis argued that existing Information Systems research on organizational agility has not sufficiently reflected on digitalization. This was seen as a cause for the lack of variety observed in the way agility is conceptualized (Salmela et al. 2015; Conboy 2009), e.g. as a static capability. Consequently, the concept of digital infrastructures was introduced to account for digitalization (Tilson et al. 2010) and enable a new way to conceptualize organizational agility. This has led to the view of organizational agility as a performance within organizations developed in this thesis, which marks a significant departure from traditional ways of conceptualizing agility.

It is argued that using digital infrastructures to conceptualize agility in a digitalized world has turned out beneficial in this thesis as it adds an awareness of digitalization and its consequences to this area of research. It thus extends the concept of agility to reflect on these changes as well. Digitalization has been discussed here around the concepts of modularity (Yoo et al. 2010), generativity (Zittrain 2008; Eck et al. 2015) and information (e.g. Kallinikos 2009). Each of these was useful to understand aspects of the case study. The role of information has been discussed above. The modularity of Telco's systems rendered them open to the kind of modifications that

were described in the case study, e.g. re-using transactional data for business intelligence in the Analytics case or adding new tools on top of existing infrastructures in the cases of OfferMaker and SalesTool. Thus, it was an important aspect supporting innovation and agility in the case study. Obviously, modular systems have existed before. The argument here is that it is important to consider modularity as a factor in information systems as it is likely to play a bigger role in the future, e.g. with tools like cloud computing turning the provision of information systems into a service (Venters & Whitley 2012). Yoo's (2013) argument to focus on generativity instead of modularity has been considered throughout this thesis. As he points out, whereas "[a] modular product begins with a fixed boundary" (p. 230), generative systems are "often designed without fully knowing the 'whole' design of how each module will be integrated with other modules" (ibid.). This again is due to digitalization and the amounts of information it creates. In this sense, the examples given above can also be seen as cases of generativity. The focus of the case study was not only in the modular systems and how they changed, but also in the way they were used by their users and developers, and the generative effects of this that led to the innovations described in the case study.

This discussion shows that Information Systems research in general would benefit from a stronger focus on digitalization. This has been useful to conceptualize agility in this case, but can conceivably be used in broader areas as well, e.g. to understand the role of information systems in shaping large corporations more generally. As Sørensen & Landau (2015) put it, Information Systems research should look at the "complex interrelationships between the granular and the infrastructural" (p. 167). This thesis follows that call by explaining the interactions of users and developers with digital infrastructures, and seeking to do so in a way that is relevant in other contexts as well. As the field of Information Systems research is currently discussing how to conceptualize the changing role of IT and its relation to the organization as a consequence of digitalization (Yoo 2013; Grover & Lyytinen 2015), this thesis can contribute to the debate by applying and developing this concept.

This will also lead to a focus on concepts like generativity and the role of information, both of which seem to have large explanatory potential and should play a role in future research beyond the narrow area of organizational agility. This thesis

serves as an example for this approach, addressing Yoo's (2013) call for research mentioned above. It also adds to the literature on organizational agility by providing researchers with an alternative lens to conceptualize it. As digitalization has not been broadly considered in research on organizational agility, this approach should prove useful for future research. Moreover, as illustrated in the literature review, agility and digital infrastructures stem from rather different traditions, so combining them opens up new possibilities, especially by strengthening the case for doing research based on qualitative data and interpretive analysis within the area of Information Systems strategy.

8.4.2 Digital infrastructures in large companies

In the literature review on digital infrastructures, it was found that, while the concept is well established in recent Information Systems research, it has not yet been used much in areas usually researched by management-focussed researchers, including organizational agility. This thesis contributes to the literature applying the concept in more traditional business/ IT contexts (e.g. Obrand et al. 2012; Henfridsson & Bygstad 2013; Karimi & Walter 2015). Thus, it responds to Tilson et al.'s (2010, p.757 f.) call for research aimed at a "better understanding of the ways in which infrastructural change shapes IT governance, IS development, and promotes new effects across all levels of analysis". Conceptualizing information systems in traditional environments like large companies as digital infrastructures has proved useful in this thesis as it puts a focus on the evolution of such infrastructures and the performances that generate them. It seems promising to apply the concept in similar studies.

8.4.3 Explanatory research in a big data world

Beyond these more specific contributions, this thesis also contributes to wider debates on how to conduct research in the social sciences. There is an on-going debate on the benefits of two styles of research, which have been associated with the use of quantitative versus qualitative data in this thesis. As pointed out, these roughly relate to the research approaches of positivism and interpretivism. This debate, variously called "Paradigm Wars" (Mingers 2004a) or "A Tale of two Cultures" (Goertz & Mahoney 2012), has not been problematized much in this thesis, which took the view that both styles of research have their strengths and should be used accordingly.

Moreover, the chosen ontology of critical realism has been described as subsuming elements of both positivist and interpretivist research (Mingers 2004b).

More broadly, some authors have proclaimed a crisis of the social sciences. Flyvbjerg (2001) argues that "social science never has been, and probably never will be, able to develop the type of explanatory and predictive theory that is the ideal and hallmark of natural science" (p. 4) and that "we must drop the fruitless efforts to emulate natural science's success in producing cumulative and predictive theory; this approach simply does not work in social science" (p. 166). In a similar vein, Savage & Burrows (2007) argue that researchers should "abandon a sole focus on causality (which we are very bad at) and analysis and embrace instead an interest in *description and classification*" (p. 896, italics in original). It is hoped that this is not the case, and that this thesis, along with other recent research aimed at identifying mechanisms, can help to offer an alternative to this view.

Savage & Burrows also make an interesting point about methods, as they find that "both the sample survey and the in-depth interview are increasingly dated research methods, which are unlikely to provide a robust base for the jurisdiction of empirical sociologists in coming decades" (p. 885). Instead, they argue for the use of social transactional data, giving the example of a list of several billion phone calls made on a particular system. This relates to aspects of this thesis, e.g. the concept of informatization (the phone calls themselves, seen as data, have been converted to information and can now be analysed), but also ties in with the Analytics efforts in Telco. Certainly, this is one indicator of how digital methods (Rogers 2013) may influence research in the future. It is certainly worth noting that, although the methods of data collection applied in this thesis served its purposes well, the thesis is quite conservative in its choice of methods. Future research could benefit from a combination of traditional methods like interviews and digital methods like netnography (Kozinets 2010) or some data analytics to support the development of explanations.

Against this background, it is understandable that research approaches based on big data have been met with much interest. The notion of a new paradigm has understandably raised hopes in big data as an element of research methodology. Such hopes, however, are often formulated in a very deterministic way (as in Mayer-Schönberger & Cukier 2013). The undisputed relevance of big data has led to claims

that “the data deluge makes the scientific method obsolete” (Anderson 2008), which tie in with the crisis of social science discussed above. However, it appears that research based on big data is just a continuation of the positivist method of inductive conclusions based on statistical generalization. Thus, even though it operates at a bigger scale and higher speed, it would still be open to the same criticism that has been raised against positivism. Following Blaikie (2007), Robson (2011) lists some points of criticism, including “[d]oubts about the claim that direct experience is a sound basis for scientific knowledge” (p. 21). This has been extensively discussed by Popper (2005), who argues that inductive logic, based on making general statements on the basis of observations, is flawed and that researchers should instead make claims and try to falsify them (deductive logic). Anyway, it appears certain that even in a big data world, a variety of research approaches will continue to be useful. Kitchin (2014) shares the view of data-intensive research as a new paradigm, but is more careful about making universal claims, instead arguing for “using a hybrid combination of abductive, inductive and deductive approaches to advance the understanding of a phenomenon” (p. 137). Given the logic of critical realism employed here, which is based on abduction and retroduction, it should be easy to relate this thesis to such discussions.

More specifically in the field of Information Systems, the research approach outlined here can help to develop the stream of research in the tradition of the social sciences further, which currently tries to define its role in a landscape where the majority of research is positivist (Mingers 2004b) and big data based research has led to speculation about the “end of theory” (Anderson 2008) in general. In this context, this approach may contribute to addressing some of the issues currently debated in the field and outlined above (2.2.3). The changing nature of technology and its role in organizations can be addressed by conceptualizing such technology as digital infrastructures and focussing on the mechanisms generating it, as done in this thesis. As for the lack of original theories (Grover & Lyytinen 2015), this research is rooted in the traditions of the field and its main theories stem from it. Perhaps the approach outlined here can contribute to developing a programme of research using such theories.

Finally, as Avgerou (2013) argues, qualitative Information Systems research should strive to provide an alternative to positivist research "by altering its epistemic script to include the tracing of social mechanisms" (p. 411). As discussed before, this ties in with critical realism's quest to identify generative mechanisms. By doing so, this thesis contributes to strengthening the body of qualitative research in this tradition. Moreover, it has been shown in the discussion on generalizability that level two inferences can be equally drawn from statistical generalizations (based on a sample of a population) or from the findings of cases studies. The discussion on data and information in a critical realist perspective has shown how big data tools are able to extend the domain of the empirical. However, as the domain of the real cannot be directly observed, big data based approaches have no access to it either. The only way to research generative mechanisms in the domain of the real remains to hypothesize them and research their explanatory potential, e.g. using the method of retroduction as in this thesis. Thus, there is hope that such research approaches will remain relevant even in the age of big data.

8.5 Methodological contribution: Defining mechanisms

To support the view on explanatory research outlined above, this thesis contributes some insights into the concept of generative mechanisms, along with advice on how to identify them. As argued in the research design chapter (4.4.4), the concept of mechanisms – either as generative mechanisms in critical realism (Mingers 2004b), or more generally as social mechanisms (Avgerou 2013) – is useful in interpretive research, as it has the potential to lead to research results that can be generalized beyond the case where they originated. However, it was also shown how the concept of mechanisms and the process of identifying them often remain vague, with little practical support given to researchers. This thesis contributes some insights here, as it applies the framework for explanatory research by Danermark et al. (2002) and combines it with a more general, hermeneutic approach. With regards to the definition of mechanisms, it argued (following Avgerou (2013)) for seeing generative mechanisms as a subset of social mechanisms. Thus, the approach taken here can serve as an example for research looking to define mechanisms in either tradition.

This thesis contributes a more specific notion on how to define generative mechanisms. As discussed in the research design chapter (4.4), the principle of retroduction

often remains vague, with Wynn & Williams (2012) pointing out that "[s]pecific guidance for retroducing mechanisms is problematic at best given the inherently creative and intuitive nature of the process" (p. 800). This thesis addressed this issue by applying the detailed framework defined by Danermark et al. (2002) and embedding this within the broad method of analysing qualitative data outlined by Miles & Huberman (1994). This enables qualitative researchers in this tradition to consider undertaking explanatory research based on the principle of retroduction. Within this framework, this thesis has followed an iterative approach inspired by the principle of the hermeneutic circle as invoked by Krippendorff (2004), thus stressing the iterative nature of the process of retroduction. This combined the flexibility of a research design in the tradition of qualitative data analysis with specific guidelines on how to define mechanisms using the method of retroduction as advocated in critical realism. This should be relevant for researchers looking to undertake similar projects, thus it would be worth developing into a paper.

8.6 Practical contributions

The practical relevance of the findings has been pointed out throughout the analysis (Chapter 6). It is summarized and discussed in this section. As discussed earlier, Information Systems as an applied discipline should aim at producing results that are relevant to practitioners. One way this has been addressed in this thesis is by defining mechanisms that can be generalized to other cases (see Table 18, p. 162). It is worth considering the relevance of this research for practitioners in some more detail. As stated at the beginning of this thesis, people in companies feel that they are under increasing competitive pressure and thus have to be able to react and adapt quickly to what happens in the outside world. Thus, there is broad interest in the concept of agility and in recommendations how to achieve it. This thesis set out with the goal to develop a better understanding of agility and how it can be supported by digital infrastructures. This section will discuss how the findings contribute to such an understanding, based on the mechanism of agilization and its aspects of bounded agility, cultivating digital infrastructures and minding flows of information.

8.6.1 Bounded agility

The mechanism of agilization encourages practitioners to aim for an appropriate level of agility, as illustrated by the concept of bounded agility. This is interesting, as it has been shown that there is not much differentiation in the literature regarding the value of agility. In practice, however, it is likely that companies would not aim at agility indiscriminately, but do so according to their needs, which may be based on factors like the market they are in, the company's size, regulatory restrictions etc. Moreover, such agility may be constrained to small parts of the organization, as expressed by the limits of scope discussed in the context of bounded agility (7.3). Consequently, the concept of bounded agility has significant practical relevance as it can guide practitioners to critically assess the level of agility that is useful for their specific needs. It also leads to the recommendation to seek agility in small pockets, e.g. in parts of the organization where it can have an impact (boundaries of scope) and at the level suitable for their situation (boundaries of degree). Thus, it has the potential to enable companies to plan agility initiatives that suit their specific needs.

8.6.2 Cultivating digital infrastructures

Regarding the question of how to achieve the desired degree of agility, the explanatory framework proposed in this thesis should be useful for practitioners. The analysis showed that digital infrastructures enable performances of agility in organizations by their specific qualities like generativity on the one hand, and constrain them by factors like the installed base of IT on the other. It is important to remember that causality in critical realism is contingent rather than deterministic (Klecun et al. 2014). Thus, even though the mechanisms identified in the case study were present in Telco, they cannot simply be recreated in other contexts. However, some useful recommendations can be derived from them.

The proposed mechanism of agilization refers to cultivating digital infrastructures and minding flows of information to attain an appropriate level of agility. This leads to a number of recommendations for practitioners. Firstly, companies should define their existing systems as digital infrastructures, then focus on harnessing them and trying to influence their growth. The concept of digital infrastructures as heterogeneous, evolving systems illustrates why it can be hard to make changes to historically grown systems. Portfolios of heterogeneous systems similar to the ones observed in

Telco are likely to exist in many organizations. Attempts to shape them should take their infrastructural nature into account. This is stressed by the mechanism of infrastructuralization, which encourages practitioners to see the information systems in their organization as digital infrastructures by taking a more modular, service based, open perspective on them. As shown in the analysis chapter, ways to shape such infrastructures include tinkering (Ciborra 1992) and cultivating (Grisot et al. 2014). Thus, once information systems are seen as open, heterogeneous systems, this may enable invention and prototyping by end users like in the cases observed in Telco. In this view, organizations can harness their digital infrastructures in order to increase their agility by designing information systems so that they become flexible and open to tinkering as they support the on-going processes of work in the organization. Moreover, through the process of cultivation, change can be achieved incrementally.

8.6.3 Minding flows of information

The other important aspect of agilization, minding flows of information, is further developed by the mechanism of informatization, defined as converting data into information and managing and sharing information within a digital infrastructure. This builds upon earlier, similar concepts in the literature like informating (Zuboff 1988) and datafication (Lycett 2013).

The aspect of managing and sharing of information within a digital infrastructure illustrates the key role information plays in digital infrastructures and organizations. The three units of analysis presented in the case study illustrate how Telco could improve business practices (and the perceived level of agility) by improving the flow and management of information, as illustrated in the mechanisms of information growing, cooking and serving. All three aspects are relevant for the management of information in organizations. By analysing workflows that are perceived as lacking in agility for these aspects, users should be able to identify areas for improvement similar to the examples presented here.

One recommendation that follows from this is that companies should appreciate the role of information in digital infrastructures and plan workflows around the capture and processing of information accordingly. As a consequence of digitalization, many activities today leave data trails that would not have been accessible a few years ago. This notion has been illustrated with the transactional data produced by other

systems within Telco that became a valuable resource for their Analytics initiatives, and conceptualized in the mechanism of information cooking. Thus, a further recommendation for practitioners would be to focus on instances where such data may be available and think about ways to convert it to information and make it useful for the business. Finally, informatization can also create new products and services, as in the case of fitness trackers measuring their users' daily activities, heart rate, or sleep patterns (Shih et al. 2015). By turning this data (e.g. number of steps taken in a day) into information, they make it accessible, thus providing value to their users.

As the phenomenon of digitalization was one of the starting points for the conceptual framework, it is worth noting that this process is still on-going and likely to affect more industries and companies as digitalization leads to "IT tearing down the old analog world and its associated social infrastructures" (Tilson et al. 2010, p.756). Although more research is needed, the framework presented here provides some first steps for companies to think about the effects of digitalization on their business and how to address it.

8.7 Limitations

8.7.1 Case and generalization

As discussed, Telco represents just one case of a company whose employees are striving for agility, although it can be seen as a typical case (4.2.2). As shown in the research design chapter (Chapter 4), great care has been taken to ensure the case study is well designed and has a clear chain of evidence (Figure 6, p. 90) that can be followed and criticised. The question of generalizability has been discussed in section 4.5. As the research design was focused on providing results that can be generalized beyond a single case, it is worth considering how and under what circumstances the explanatory theory developed in this thesis can be used in other contexts. The goal of identifying a middle range theory capable of being applied to broader contexts was expressed in the conceptual framework and the research design, which focussed on identifying generative mechanisms with some amount of generalizability.

The research design chapter has introduced the concept of analytic generalization, exemplified with the logic of case studies (4.2.1), in which findings are generalized to a theory, and discussed how this fits with the tradition of generalization in the Information Systems field. As illustrated in the analysis (Chapter 6), the theory developed here has been derived iteratively based on the conceptual framework. Generalizability can be seen to depend on two factors: the quality of the research design and its execution, and the question of how context dependent the identified mechanisms are.

As discussed in the research design chapter (4.2.1), there is some consensus that findings from case studies can legitimately be generalized to other contexts. The degree of this generalizability depends on the quality of the research design and its execution. This thesis has made great efforts to come up with, and execute on, a research design that is solid enough to allow for a degree of generalization beyond the specific case of Telco. It is ultimately up to the reader to decide how convincing they are.

On the other hand, the question of context is harder to address, as causality in critical realism is contingent and "placing the same technology in a different context does not imply that the same mechanisms will be activated" (Klecun et al. 2014, p.151), Consequently, critical realism does not aim to make statements of universal validity. One consequence of this is that mechanisms will not lead to the same outcomes in all cases, and the same mechanisms will not necessarily occur in other contexts, even under similar circumstances. One way to address this issue, as demonstrated by Henfridsson & Bygstad (2013), is to conduct a case survey that looks at other case studies in order to find out whether the same mechanisms can be identified there and under what conditions they are actualized. This would be a useful endeavour for future research. Nevertheless, it is important to consider now to what extent the mechanisms and theory defined here are contingent on the context of Telco, as this can give some insights into their generalizability. Some specific conditions were identified within Telco and seen to support the mechanism of bounded generativity (6.4.2). Although that mechanism was not included in the conceptual framework, the conditions are still worth considering:

- A mindset that supports innovation and risk taking, but within limits imposed by elements like regulations and risk control, and
- The existence of flexible digital infrastructures.

As a high-tech company, Telco has a large number of technically skilled employees. Thus, it may be more likely to come up with examples of tinkering and bottom-up innovation like in the cases described in this thesis. Moreover, Telco's employees were encouraged to engage in such innovation (within the limits described in the case study). It would be interesting to study whether such innovation can also occur in large companies in other sectors. Secondly, the fact that the historically grown digital infrastructures within Telco were flexible enough to afford the innovations described in this thesis was an important factor supporting the mechanisms. Again, it would be interesting to consider to what extent such infrastructures exist in other sectors (or even other high-tech companies), and to what extent companies are willing to engage in tinkering and bottom-up innovation.

These conditions may indeed limit the generalizability of the findings. On the other hand, it is hoped that the theory developed here is still applicable in other contexts. Future research should be able to give more insights into this.

8.7.2 Data collection

Limitations to the research approach chosen have been pointed out before. These mainly relate to the methods of data collection (4.3) and analysis (4.4) used in this thesis. As any methods, they have their limitations, so, at the end of the thesis, it is useful to reflect on them again. As pointed out in the research design chapter, interviews involve a degree of subjectivism in their interpretation (Holstein & Gubrium 1997), and even transcribing them can be seen as an act of construction and sense-making (Hammersley 2010). This has been addressed in this thesis by following established guidelines for doing rigorous qualitative research, especially Miles & Huberman's (1994) outline of the qualitative research process and their quality guidelines and Wynn & Williams' (2012) advice on conducting critical realist research. Moreover, with regards to Savage & Burrows' (2007) criticism of traditional research methods like interviews, it was found (8.4.3) that future research could

benefit from a combination of such methods and new methods like netnography or big data analysis.

8.7.3 Data analysis

The method of retroduction, used here to identify generative mechanisms based on the case study data, has known limitations in that there is no simple way to identify mechanisms. This has been described as the "inherently creative and intuitive nature of the process" by Wynn & Williams (2012, p. 800). This is a common concern with critical realist research and has been addressed here by applying the staged model for explanatory research by Danermark et al (2002). This gives useful guidelines on how to elaborate this creative process and makes it easier for readers to follow and criticise the process of retroduction as applied in this thesis. Due to its interpretivist epistemology, critical realism will never be able to provide unambiguous methods and results the way positivist research does – as Wynn & Williams point out, there will always be multiple possible explanations. This, however, makes up a large part of the appeal of the ontology, especially if one does not believe such unambiguity is possible.

8.7.4 Terms

As shown in this thesis, the concept of agility as a performance has the potential to develop the concept of agility and enrich the body of Information Systems research on agility, which so far mainly sees it as a static entity. However, more work is needed to develop the concept and illustrate how it relates to existing research on agility and where it differs.

Likewise, the use of the term performance in this thesis, while it was useful to support the current analysis, still represents an area for future development. Specifically, as discussed, terms like 'performance' and 'practice' are based in significant traditions of research and it is questionable whether, as Mol (2002) argued, the terms can or should be used interchangeably. Furthermore, clearer distinctions between these terms and other similar concepts, e.g. the relational nature of digital infrastructures (Tilson et al. 2010), should be developed.

Appendix

A: List of Interviewees

1. Head of product management
2. CIO team - Technical lead
3. Research project lead
4. Head of research practice
5. CIO team - Product consultant
6. Head of product strategy
7. Senior product manager
8. Head of strategy
9. Head of product management
10. Change delivery lead
11. Designer
12. Software developer
13. Research project lead
14. Chief product architect
15. Call centre manager
16. Call centre manager
17. Call centre advisor
18. Call centre advisor
19. Call centre advisor
20. Usability expert
21. Head of Product
22. CIO team - Strategic analyst
23. Online capability specialist
24. Sales manager
25. Sales advisor
26. (same as 23)
27. Head of customer data management
28. Executive director
29. Sales centre manager
30. Sales centre team leader
31. Sales advisor
32. Sales centre manager
33. Technical sales specialist
34. Head of CRM
35. Senior researcher
36. Head of research practice
37. (same as 35)
38. Senior researcher
39. Process architect

40. Principal researcher

o1 – o10: observations of employees in various Telco call centres

B: Initial questionnaire

1. introduction: (based on "interviewee information sheet")
    a. myself
    b. agility
    c. research project
    d. ethics/ consent – sign form
    e. any questions about that?
2. Tell me about your role in [Telco].
    a. How does that relate to agility?
3. How do you perceive [Telco]'s position in the market?
4. What is your idea of organizational agility?
    a. Does your role involve elements of agility (sensing and responding quickly to outside threats)?
    b. How do you seek to achieve it?
        i. How do you seek to be able to "adapt to market forces and new technologies"?
    c. What obstacles do you perceive?
5. What are the processes of sensing and responding involved?
    a. How does this work in practice?
    b. What sort of information is important for you? How do you get this information (sense)?
    c. How do you react/ respond?
6. Superceding planned developments
    a. what if a necessary (re)action clashes with planned developments?
        i. How is this prioritised?
        ii. Is it possible to supercede a planned development? E.g. fast-track an innovative project to react to market changes
    b. Do you think [Telco] is able to pull of new/ innovative projects at the same time as running its regular operations?
7. [Telco] as incumbent – advantage (scale) or disadvantage (red tape)?
8. What is the role of information systems/ IT in these processes?
    a. What sort of IS are used?
    b. Do IS help or hinder?
9. Overall, do you think [Telco] is doing a good job competing in the market? Why (not)?
10. Anything else you would like to add?

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