Understanding how enterprises adopt and scale agile practices and structures

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Abstract

The question of how to increase speed and flexibility in times of digital disruption is crucial to companies of almost any industry or size. While startups or "born digital" companies like Amazon, Facebook, or Google are digital and agile by nature, established companies face unique challenges when increasing agile capabilities due to legacy infrastructure, fine-tunes processes and optimized organizations. Consequently, the question of how to increase agility as organizational capability to react and readily respond to rapidly changing and volatile market demands is of highest importance.

Adopting agile practices and structures can be seen as one way to increase speed and flexibility. While agile practices are inherently linked to software development, an increasing number of companies turn into agility by adopting scaled agile frameworks. Yet, extant research still primarily focuses on agility as a software development practice or as form for organizing startups or small teams while remaining silent on how established enterprises can adopt and scale agile practices or structures.

This cumulative dissertation addresses this research gap: The first phase lays the theoretical and conceptual foundation. *Article I* examines the current state of research on digital transformation and IT. The second phase contributes with empirical and practice-based research. Specifically, *Article II* and *III* identify implications and challenges of adopting agile practices and structures at established enterprises. *Article IV* and *V* analyze how enterprises adopt and scale agile structures to their needs. *Articles VI* and *VII* derive recommendations by examining how scaled agile practices help in managing time complexity (*Article VI*) and increasing agility in IT sourcing and contracting (*Article VII*).

This dissertation contributes to theory by (1) illuminating the specific challenges and implications of adopting agile practices and structures at established companies, (2) providing empirical insights on how the adoption of agile practices or structures can help in increasing speed and flexibility, and (3) illustrating empirical cases deriving actionable recommendations on how to manage time complexity by applying scaled agile practices and increasing agility in IT sourcing and contracting. For practice, this dissertation illustrates organizational principles and lessons learned of companies applying agile practices and structures while providing actionable guidance on how to increase speed and flexibility by adopting and scaling agile practices and structures.

Zusammenfassung

Die Frage, wie man in Zeiten der digitalen Transformation Geschwindigkeit und Flexibilität, also Agilität, erhöhen kann, ist für nahezu jedes Unternehmen von zentraler Bedeutung. Während Startups oder "digital geborene" Unternehmen wie Amazon, Facebook oder Google von Natur aus digital sind, stehen etablierte Unternehmen aufgrund gewachsener Infrastruktur, bestehender Altsysteme oder hochautomatisierten Prozessen vor besonderen Herausforderungen.

Die Einführung agiler Praktiken und Strukturen kann als ein Weg gesehen werden, um Agilität zu erhöhen. Während agile Praktiken und Strukturen ursprünglich aus der Softwareentwicklung kommen und dort weitverbreitet sind, werden diese zunehmend auch von etablierten Unternehmen angewendet. Dennoch konzentriert sich die bestehende Forschung in erster Linie auf Agilität als Softwareentwicklungspraxis oder als Organisationsform für Startups oder kleine Teams, während sie gleichzeitig darüber schweigt, wie etablierte Unternehmen agile Praktiken und Strukturen anwenden.

Diese kumulative Dissertation befasst sich mit dieser Forschungslücke. Phase 1 legt theoretische und konzeptionelle Grundlagen. *Artikel I* untersucht den aktuellen Forschungsstand. Phase 2 zielt darauf ab, mit empirischer und praxisorientierter Forschung zur Weiterentwicklung von Theorie und Praxis beizutragen. *Artikel II* und *III* beschreiben die Auswirkungen und Herausforderungen der Einführung agiler Praktiken und Strukturen in etablierten Unternehmen. *Artikel IV* und *V* untersuchen, wie etablierte Unternehmen agile Strukturen an ihre Größe und spezifischen Bedürfnisse anpassen. *Artikel VI* und *VII* leiten konkrete Handlungsempfehlungen ab.

Diese Dissertation trägt zur Theorie bei, indem sie (1) die spezifischen Herausforderungen und Auswirkungen der Einführung agiler Praktiken und Strukturen in etablierten Unternehmen beleuchtet, (2) eine theoriegestützte Perspektive für die Einführung agiler Praktiken und Strukturen bietet, und (3) empirische Fälle untersucht, in denen umsetzbare Empfehlungen zur Bewältigung der Zeitkomplexität durch die Anwendung skalierter agiler Praktiken und die Steigerung der Agilität in der IT-Beschaffung und -Vertragsabwicklung identifiziert werden. Für die Praxis veranschaulicht diese Dissertation organisatorische Prinzipien und Erfahrungen etablierter Unternehmen und gibt Hinweise, wie Geschwindigkeit und Flexibilität durch die Einführung agile Praktiken und Strukturen erhöht werden können.

List of Abbreviations

DevOps ..... Development and Operations

IS ..... Information Systems

ISD ..... Information Systems Development

IT ..... Information Technology

LeSS ..... Large-Scale Scrum

OEM ..... Original Equipment Manufacturer

OES ..... Original Equipment Supplier

PMA ..... PhD Program in Management

PromO ..... Promotionsordnung

RQ ..... Research Question

SAFe ..... Scaled Agile Framework

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Part A – Synopsis and Reference Overview of Articles in this Dissertation

1. Introduction

Digital transformation is ubiquitous and requires companies to "rethink how they interact with customers, define value propositions, leverage data, and organize internal operations" (Joehnk, Röglinger, Thimmel, & Urbach, 2017, p. 1). New competitors create new products or services and business model innovation takes place with the help of new digital technologies (Weill & Woerner, 2015). Therefore, digital transformation imposes the need to continually sense and respond appropriately to frequently changing markets (D'Aveni, Dagnino, & Smith, 2010; Overby, Bharadwaj, & Sambamurthy, 2006). Against this backdrop, the question of how to increase organizational agility plays a crucial role as companies are creating new combinations of digital and physical components for product innovation in response to rapidly changing and volatile market environments (Yoo, Henfridsson, & Lyytinen, 2010).

While digital technologies are fundamental to business innovation and entrepreneurial outcomes (Tumbas, Berente, & vom Brocke, 2017b), the foundations of agility are inherently linked to software development (Conboy, 2009; Kulak & Li, 2017; X. Wang, Conboy, & Pikkarainen, 2012). Agile practices root in the Agile Manifesto, a practitioners' collection of best practices on how to improve speed and flexibility in software development while simultaneously reducing frictions and errors (Fowler & Highsmith, 2001). Still today, agile practices are predominately perceived as (1) a method for software development (X. Wang et al., 2012), (2) suitable only to small units with co-located software developers in non-safety critical context (Scott W. Ambler, 2001; Dikert, Paasivaara, & Lassenius, 2016), or (3) as part of bimodal settings where agility can be experimented with in small and strategically non-relevant units (Haffke, Kalgovas, & Benlian, 2017a, 2017b; Horlach, Drews, Schirmer, & Böhmann, 2017). Recent studies reveal that agile practices and structures play an increasing role also for established enterprises outside software development context or small and isolated teams.

Enterprise agility can be defined as an organizational capability to sense environmental change and respond appropriately (Overby, Bharadwaj, & Sambamurthy, 2005) and is essential for successfully mastering digital transformation (Highsmith, 2013). Enterprises are understood as established businesses that are – unlike Amazon, Facebook, or Google – not "born digital" and are of considerable size and in business for years. In times of digital transformation, many companies striving for agility are in transition from non-agile or bimodal IT structures towards agile structures as they seek

to increase speed and flexibility (Ellermann, 2017; B. Fitzgerald & Stol, 2017; Roemer et al., 2017). Enterprises adapt their organizational structures and processes accordingly towards achieving a suitable accompanying organizational foundation for leveraging digital technologies (Dremel, Herterich, Wulf, & Vom Brocke, 2018). Consequently, the traditional way of software development following a "waterfall-approach" with an IT organization structured according to "Plan-Build-Run" (Royce, 1987) is currently complemented by a large extend or even being replaced by agile practices and structures (B. Fitzgerald & Stol, 2017; Kulak & Li, 2017). Established companies adopt agile practices and structures at large scale to increase speed and flexibility with the objective to increase enterprise agility (Sebastian et al., 2017).

Despite the growing agility literature (Conboy, 2009; B. Fitzgerald & Stol, 2017; X. Wang et al., 2012), research on how enterprises that are by their nature not "born digital" adopt and scale agile practices and structures to their needs to strengthen their agile capabilities calls for a deeper understanding of (1) the applicability and specific challenges of agile practices or structures outside Information Systems Development (ISD) (Kiely, Kiely, & Nolan, 2017) or beyond small and co-located development teams (Abrahamsson, Conboy, & Wang, 2009), (2) the impact of agile practices on established enterprises (Gerster, Dremel, & Kelker, 2018), (3) how organizations can be structured to take advantage of agile practices and structures (Abrahamsson et al., 2009; Maruping, Venkatesh, & Agarwal, 2009), (4) empirical evidence, their use, effectiveness, and challenges of scaled agile frameworks (Conboy & Carroll, 2019; Dikert et al., 2016), and (5) evidence-based guidelines on how organizations can be structured to maximize benefits of adopting agile practices and structures (Maruping et al., 2009).

Against this backdrop, the following overarching research question for my cumulative dissertation can be formulated:

> *How do traditional enterprises adopt and scale agile practices and structures to increase speed and flexibility?*

This dissertation aims at providing a deeper understanding of how established enterprises can increase speed and flexibility by adopting agile practices and structures according to their needs and scale.

2. Theoretical Background

This section introduces the main theoretical concepts relevant for this dissertation. I refer to the roots of agility and related concepts in IS research like bimodal IT, organizational ambidexterity, scaled agile practices, and enterprise agility as an organizational capability.

2.1 Roots of Agile Practices and Structures: Software Development

Agile practices and structures are closely related to IT due to their roots in ISD. Agile practices can be perceived as a response to challenges emerging from the traditional way of software development according to "Plan-Build-Run" (Royce, 1987) and the resulting separation between build and run (Rigby, Sutherland, & Takeuchi, 2016). Agile practices root in systems thinking and lean practices (Kulak & Li, 2017; Larman & Vodde, 2017; Leffingwell, 2007). Systems thinking is about changing our perspective to solve problems in new and unexpected ways (Deming, 2000). The Agile Manifesto is perceived as a practitioners' collection of best practices on agile ISD and aims at designing "better ways of developing software by doing it and helping others do it" (Fowler & Highsmith, 2001, p. 2). The Agile Manifesto applies principles of systems thinking to software development: Individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (Fowler & Highsmith, 2001).

Agile practices can be exemplarily characterized as follows: Formulation of value stories, removing complexity, shortening release cycles to incorporate customer feedback, and the estimation with story points to reduce effort estimation complexity (Conboy, 2009; Rigby et al., 2016; Wang et al., 2012). Agile practices aim, for instance, at clean code, pair programming and immediate customer feedback, test-driven development, automated testing, continuous deployment (Fitzgerald & Stol, 2017; Kulak & Li, 2017) and achieve their benefits through the synergistic combination of individual agile practices (Fitzgerald, Hartnett, & Conboy, 2006).

Agile structures have been initially applied by startups and "born digital" companies to reflect the application of organizational practices also in organizational structures (Gonçalves & Lopes, 2014; Kniberg, 2012). A generic template for a fully agile unit as applied by Spotify has been initially described by Kniberg (2012) and has been further developed by Gonçalves and Lopes (2014). While Kniberg focuses on agile structures

as applied by Spotify, Gonçalves and Lopes focus on agile practices and how the scaled agile practise LeSS (Large-Scale Scrum) has been implemented and adopted by Spotify.

The smallest unit of a fully agile structure – an agile team – is typically called "squad" or product/feature team. A squad is designed like a "mini startup" and has overall responsibility for a defined product or feature and is therefore often called product or feature team (Gonçalves & Lopes, 2014; Kniberg, 2012). A squad has all required resources to design, develop, test, and deploy features and is a small cross-functional, hierarchically flat and self-organized team (Kniberg, 2012). The aim is to keep the team size small and to follow the so-called "two-pizza team" rule, i.e. a team only as large as can be fed with two pizzas – usually about five to ten team members (Kim et al., 2016). To facilitate communication within the team, members are usually collocated and sitting together. Squads are self-organizing and decide on their own way on how to work as they are basically free of hierarchies (Kniberg, 2012). With these design principles of an agile team at hand, required decisions along with implementation can be made almost instantaneously as – ideally – all required competencies for are available within the squad (Gonçalves & Lopes, 2014; Kniberg, 2012). By this, agile structures can help in reducing the time required for decisions, design and implementation.

In consequence, agile practices and related structures have become an appealing option for companies to improve their performance, but these agile methods were originally designed for small and collocated teams (Dikert et al., 2016). Similarly, challenges emerge as introducing agile practices in the IT function alone is not enough and requires "a more holistic approach […] than one which is merely focused on continuous integration of software" (Fitzgerald & Stol, 2017, p. 176) to increase performance at the entire organization. Consequently, the benefits of introducing agile practices and forms of organizational design will be sub-optimal if not complemented by an agile approach in related functions outside IT (Leffingwell, 2007; Overby, Bharadwaj, & Sambamurthy, 2005).

2.2 Increasing Speed and Flexibility through the Adoption of Agile Practices

Key issues inherent to traditional ISD are that developing complete functional specifications is usually (1) not economical since it requires considerable effort before implementation starts (Book, Gruhn, & Striemer, 2012); (2) not feasible since learnings of first iterations of feature development cannot be incorporated (Kim, Debois, Willis,

& Humble, 2016); and (3) not helpful since the client usually remains unable to express all requirements in sufficient complete and consistent detail up front (Kulak & Li, 2017).

Contrary, agile practices can help to address some key issues of traditional ISD: First, the recognized lack of helpfulness of a complete up-front specification of functional requirements has led to the rise of agile software development methods such as Scrum (Schwaber & Beedle, 2002) where voluminous specifications are replaced by lean specifications to achieve simple design (Book et al., 2012). Second, sprints are planned according to business priorities as specified by the product owner as a representative for the client's business priorities (Wang et al., 2012). Third, small releases are deployed in short, iterative sprint cycles of two to three weeks for an early go-to-market with gradual improvement (Hekkala, Stein, Rossi, & Smolander, 2017). Short sprint cycles ensure that new features can be deployed early, shipped iteratively, and piece by piece (Austin & Devin, 2009). Furthermore, changing requirements can be considered within a reasonably short timeframe (Ågerfalk, Fitzgerald, & Slaughter, 2009). Fourth, continuous testing and integration ensure that new functionality will be tested and deployed instantaneously without waiting for big release bundles increasing the risk at integration tests (Fitzgerald & Stol, 2017). Fifth, pair programming ensures a quality check already during coding as one developer codes and another checks quality (Fitzgerald & Stol, 2017). Sixth, distributed leadership and decision-making speed up decision making and ensure that required information is readily available empowering self-organizing teams (Hekkala et al., 2017). Seventh, daily stand-ups and retrospectives serve as supporting organizational culture as they facilitate team communication on sprint status and foster learning and continuous improvement (Hekkala et al., 2017; Recker, Holten, Hummel, & Rosenkranz, 2017).

Applying these agile principles to ISD help to increase speed and flexibility in three ways: First, time-to-market for critical features can be reduced as features with high business impact can be prioritized by the product owner (Ågerfalk et al., 2009). Second, product quality can be increased due to early and automated testing, incorporated quality checks due to pair programming, communication and mutual feedback (Fitzgerald & Stol, 2017). And third, flexibility for deployment of frequently changing features can be increased due to short, iterative sprint cycles and lean requirements specification (Coram & Bohner, 2005).

In consequence, an agile and iterative approach can – by design – reduce risk and uncertainty as implementation takes places in short waves and customer feedback can be received instantaneously to allow for further, gradual improvements (Arbogast,

Larman, & Vodde, 2012). An agile approach limits the scope of the deliverable and allows for inevitable change (Arbogast et al., 2012). In consequence, agile practices can contribute in increasing speed by reducing time-to-market of critical features and in increasing flexibility (Conboy, 2009; Wang et al., 2012). By taking agile practices and structures into account, enterprises are enabled to transform their organizational systems towards providing a suitable accompanying organizational foundation for leveraging emerging digital technologies (Dremel, Herterich, Wulf, & Vom Brocke, 2018).

2.3 Bimodal IT and Organizational Ambidexterity

The term bimodal IT was coined by practitioners and is related to the underlying concept of ambidexterity. Ambidexterity is the capability of simultaneously pursuing exploitation and exploration (O'Reilly & Tushman, 2008; Raisch, Birkinshaw, Probst, & Tushman, 2009) where exploration is related to innovation and to "recombine potential resources in novel ways to create new capabilities and opportunities" (Lee, Sambamurthy, Lim, & Kwok Kee, 2015, p. 400). Contrary, exploitation relates to the efficient leverage and refinement of existing resources through known processes (Lee et al., 2015; March, 1991). Bimodal IT refers to this ability of managing two separate but coherent working styles simultaneously: One focusing on exploration, the other on exploitation (Bygstad, 2015). Companies engage in bimodal IT to increase IT agility, IT explorative capabilities, and the need for a structured business-IT alignment (Haffke et al., 2017a; Horlach, Drews, & Schirmer, 2016). Inherent to bimodal IT is that an – usually small and strategically non-relevant – agile unit is established to co-exist with predominately non-agile units handling core business processes (Haffke et al., 2017b). While bimodal IT might be suitable to increase speed and flexibility within a short period of time in a specific unit, it is not suitable to increase speed and flexibility at the entire organization (Haffke et al., 2017a; Horlach et al., 2016). In consequence, an increasing number of organizations is adopting agile practices and structures at large units or even at the entire organization to increase agility (Conboy & Carroll, 2019; Kalenda, Hyna, & Rossi, 2018; Schuch, Gerster, Hein, & Benlian, 2020).

2.4 Scaling Agile Practices and Structures

As organizations scale, so do IT development and operations units. While they may initially be co-located with close communication links, increased team size and a stricter separation of responsibilities can weaken such links (Boehm & Turner, 2005; Swartout, 2014). Practitioners made several attempts to scale agile practices to the enterprise level

by adapting agile practices known from ISD and new agile forms of organizational design.

To address the inherent challenges of implementing scaled agile practices at larger organizations, frameworks for scaled agile practices emerged (Dyba & Dingsoyr, 2009): LeSS is a lightweight agile framework developed by Craig Larman and Bas Vodde for scaling Scrum to more than one team (Larman & Vodde, 2017) and SAFe (Scaled Agile Framework) is another approach developed by Dean Leffingwell for lean agile thinking and more visibly incorporating of scalable DevOps (Leffingwell, 2007; ScaledAgile, 2017). A variety of agile practices has emerged with Extreme Programming, Kanban, Lean Startup, LeSS, Nexus, SAFe, and Scrum at Scale as the most prominent ones (Versionone, 2018).

The adoption of agile practices and forms of organizational design at large scale is faced with challenges like communication issues (Schuch et al., 2020). A lack of flexibility or openness and willingness to transform is besides of coordination challenges an often-underestimated prerequisite for a successful implementation (Conboy & Carroll, 2019). Furthermore, agile practices can only be scaled to a limited extent (Paasivaara, Lassenius, & Heikkilä, 2012).

2.5 The Underlying Concept of Enterprise Agility

Related but different from scaled agile practices and forms of organizational design is the concept of enterprise agility which is defined by Overby et al. as "the ability of firms to sense environmental change and respond readily" (2006, p. 121). Enterprise agility has its origins in management research and explains how to successfully navigate in turbulent environments (Overby et al., 2006). Enterprise agility is an organizational capability of continually sensing market change and responding appropriately (D'Aveni et al., 2010; Overby et al., 2005). These capabilities to "detect and seize market opportunities with speed and surprise" (Sambamurthy, Bharadwaj, & Grover, 2003, p. 238) help firms to continually develop new competitive actions and gain sustainable competitive advantage (D'Aveni et al., 2010). Adopting agile practices and forms of organizational design can be perceived as one way to increase these capabilities related to enterprise agility (Highsmith, 2013; Kulak & Li, 2017).

In summary, I understand agility as a multidimensional concept (Abrahamsson et al., 2009; Holmström, Fitzgerald, Ågerfalk, & Conchúir, 2006) where speed (Lyytinen & Rose, 2006) and flexibility (Highsmith, 2009) are key elements.

This dissertation aims at addressing existing research gaps related to how established enterprises can increase agility by adopting agile practices and structures according to their needs and scale. Explicitly, this dissertation aims at contributing to the extant knowledge regarding (1) the impact and specific challenges resulting from applying agile practices and structures at established enterprises outside ISD (Kiely, Kiely, & Nolan, 2017) or beyond small and co-located development teams (Abrahamsson, Conboy, & Wang, 2009), (2) how organizations can be structured to take advantage of agile practices and structures (Abrahamsson et al., 2009; Maruping, Venkatesh, & Agarwal, 2009), and (3) guidelines and managerial recommendations on how agile practices and structures can contribute in increasing organizational agility (Conboy & Carroll, 2019; Dikert et al., 2016; Maruping et al., 2009).

The subsequent section reveals the structure of this cumulative dissertation and explains how the articles address the research questions that have been formulated in response to the research gaps.

3. Structure of this Dissertation

To better grasp the phenomenon of interest (i.e., to understand how enterprises adopt and scale agile practices and structures), the overarching research question of the cumulative dissertation is split into three research questions (RQ) as follows.

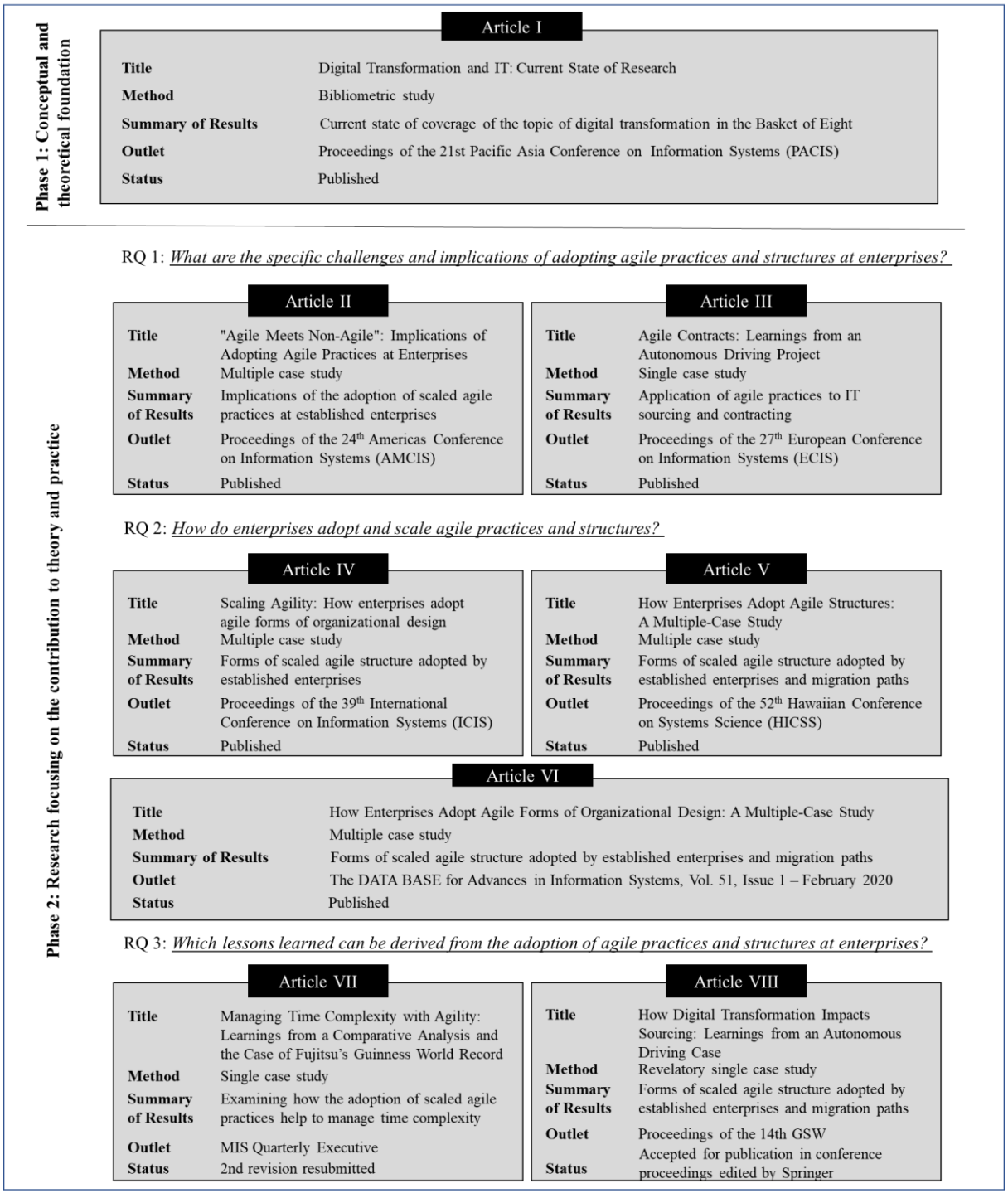

Figure 1. Overview of Dissertation Structure and Constitutive Articles

Figure 1 provides an overview of how the three RQs are addressed in individual paper projects that contribute to the overall research question of this cumulative dissertation.

The overall approach of this cumulative dissertation draws on a multitude of research paradigms and methods such as systematic literature review (vom Brocke et al., 2015; Webster & Watson, 2002), the socio-technical systems theory (Bostrom & Heinen, 1977; Leavitt, 2013), and single and multiple case study design (Eisenhardt, 1989; Yin, 2009). Most papers of my cumulative dissertation rely on exploratory research to generate rich insights (Shepherd & Suddaby, 2017) and aim at providing empirical evidence in the process of data collection and analysis (Seidel & Urquhart, 2013).

The following section outlines how my overarching research question is addressed by seven articles that split up according to three research questions.

The findings related to phase 1 of this dissertation look at the current state regarding research on digital transformation. *Article I* examines to which extent topics addressing digital transformation are already covered by publications in leading IS journals, the so-called "Basket of Eight" (i.e. the leading eight IS journals in terms of impact factor). *Article I* provides the foundation for the applied research on how established enterprises adopt agile practices and structures to address challenges resulting from digital transformation.

Phase 2 of my cumulative dissertation examines the current state of how established enterprises (i.e. not "born digital" companies or startups) apply agile practices and structures. This overarching topic is analyzed with three research questions that are outlined in more detail as follows.

Despite the growing agility literature (Conboy, 2009; X. Wang et al., 2012), research on agility as phenomenon is still rare (Hekkala, Stein, Rossi, & Smolander, 2017). Current research focuses on agility as a method of ISD (B. Fitzgerald & Stol, 2017), or perceives agility as only suitable to small units with co-located software developers in non-safety critical context (Scott W. Ambler, 2001; Dikert et al., 2016). There is a lack of literature regarding challenges and implications of adopting agile practices and structures at enterprises (Kettunen & Laanti, 2008; Leffingwell, 2007; Reifer, Maurer, & Erdogmus, 2003). In consequence, I propose the following research question:

RQ1: What are the specific challenges and implications of adopting agile practices and structures at enterprises?

This RQ aims at addressing the research gap related to the applicability of agile practices and structures outside ISD or at small and collocated teams like at startups (Abrahamsson et al., 2009; Kiely et al., 2017). Furthermore, the far-reaching impact of adopting agile practices and structures is examined.

This RQ is addressed with two articles. *Article II* applies the socio-technical systems theory (Bostrom & Heinen, 1977; Leavitt, 2013) and examines the widespread implications of the adoption of agile practices at established enterprises. In detail, *Article III* takes a specific look at one area especially impacted by the adoption of agile practices, the sourcing and contracting of IT services. This article examines the widespread implications of adopting agile practices in IT sourcing and contracting in a single case study on an autonomous driving development platform. Furthermore, this article reveals how agility in sourcing and contracting of IT services can be increased by adopting agile practices and derives managerial recommendations on how to reduce tender duration and pre-contractual uncertainty and to increase flexibility related to the services in scope of sourcing.

The question of how to increase speed and flexibility is essential to almost any company (Highsmith, 2009). While previous research focuses on agility in the context of ISD or as form for organizing small and co-located teams or startups, little knowledge exists on how organizations can be structured to maximize benefits of adopting agile practices and structures (Hekkala et al., 2017; Maruping et al., 2009). Consequently, RQ2 can be formulated as follows:

RQ2: How do enterprises adopt and scale agile practices and structures?

RQ2 addresses the research gap related to empirical studies on how agile practices work in practice (Abrahamsson et al., 2009; Wiedemann, 2017) and aims at identifying empirical evidence on use, effectiveness, and challenges of scaled agile frameworks (Conboy & Carroll, 2019; Dikert et al., 2016).

This RQ is addressed with two articles: *Article IV* examines with a multiple-case study how established enterprises apply agile structures and identifies three new generic forms of organizational design for fully agile units. These new models further adapt the generic template for a fully agile unit as applied by Spotify by the specific needs and scale of established enterprises. *Article V* further extends this work with more cases to reach saturation and identifies company clusters related to the adoption of agile forms of organizational design. Furthermore, *Article V* identifies migration paths on how agile

forms of organizational design are adopted and scaled by established enterprises over time.

Increasing organizational agility is crucial for innovation and is therefore of highest strategic importance to almost any company (Highsmith, 2009; Kohli & Melville, 2018; Sebastian et al., 2017). While applying agile practices and structures is the normal modus operandi for startups or "born digital" companies (Tumbas, Berente, & vom Brocke, 2017a), traditional enterprises struggle with the question of how to increase agility (Sebastian et al., 2017).

Against this background, RQ3 aims at identifying recommendations for established enterprises related to the adoption of agile practices and structures and can be formulated as follows:

RQ3: Which managerial recommendations can be derived from the adoption of agile practices and structures at enterprises?

This RQ aims at deriving generalizable recommendations on how organizations can be structured to maximize benefits of adopting agile practices and structures (Maruping et al., 2009).

This RQ is addressed with two articles: *Article VI* examines how the adoption of scaled agile practices could help in managing time complexity and which measures should be applied by managers. With a comparative case study this paper reveals how Fujitsu, the world's seven-largest IT services provider and in business since 1935, managed to set a Guinness World Record on November 7th, 2017, on the largest animated tablet PC mosaic by applying selected agile practices. The findings at Fujitsu are compared with four other cases and reveal how the adoption of scaled agile practices can help to manage time complexity.

Finally, *Article VII* builds on the foundations of *Article III* and focuses on managerial recommendations on how to increase agility in the sourcing and contracting of large IT endeavors. This article reveals that applying agile practices to IT sourcing and contracting has two major implications: First, agile practices aim at reducing tender duration, decreasing pre-contractual uncertainty, and therefore increasing speed and flexibility. Second, agile software development changes contract nature as comprehensive requirements are replaced by high-level specifications focusing on business outcomes. This article contributes to the extant knowledge on IT sourcing and contracting by providing managerial recommendations on how to increase agility in sourcing and contracting of large-scale IT initiatives.

4. Discussion, Contribution, and Future Research

The question of how to increase agility to be adaptable and resilient while maintaining efficiency and reliability is of highest strategic importance to virtually any company in the age of digital transformation and rapid change (Hamel, 2009; Highsmith, 2009). While previous research primarily focuses on agility as software development method, agile practices applied to startups, or on bimodal IT, my dissertation is motivated by the lack of empirical evidence on how established enterprises adopt and scale agile practices and structures to their needs and scale.

My dissertation builds on extant research related to ambidexterity, bimodal IT, scaled agile practices, and enterprise agility. These concepts are further extended to explore the specifics of adoption of agile practices and structures in the enterprise context. My dissertation especially extends the existing work on the adoption of agile practices by revealing that agile practices and forms of organizational design are now implemented at large scale also at established enterprises and in business units beyond the context of ISD. Furthermore, my dissertation confirms extant knowledge that innovation leaders reorganize according to agile practices and structures (Haffke et al., 2017a; Horlach et al., 2017; Joehnk et al., 2017; Roemer et al., 2017).

4.1 Contribution to Theory

This cumulative dissertation replies to the research gap related to an improved understanding of how enterprises adopt and scale agile practices and structures by replying to three research questions.

Article I sets the stage by examining the current state of research in leading IS Journals (The "Basket of eight") related to digital transformation and reveals that while topics related to digital transformation are of high importance to practitioners, extant knowledge and related publications in leading IS journals are still rare.

Responding to RQ1, *Article II* reveals the far-reaching implications of adopting agile practices at established enterprises going far beyond of topics just related with ISD. *Article III* showcases with the specific domain of IT sourcing and contracting how the application of agile practices could improve agility in IT sourcing and contracting by reducing tender duration and pre-contractual uncertainty and increasing flexibility.

RQ2 closes the gap related to the lack of insights regarding agile forms of organizational design at established enterprises. More precisely, *Article IV* identifies three new models

for agile forms of organizational design observed at the case study companies. *Article V* further extends this work by shedding light on how established enterprises adopt agile forms of organizational design over time according their needs and scale and derives seven migration paths to master the challenges of digital transformation at established enterprises.

Finally, practice-based *Articles VI* and *VII* address the research gap on how to maximize the benefits from adopting agile practices and structures. *Article VI* reveals new insights by examining scaled agile practices through the lens of temporality theory and reveals how challenges related to time complexity can be managed by applying scaled agile practices. *Article VII* contributes to RQ3 by revealing managerial recommendations on how to improve agility in the sourcing and contracting of large IT endeavors.

4.2 Contribution to Practice

For practice, my dissertation provides managerial recommendations and guidance on how to implement agile practices and structures at established enterprises. Specifically, this dissertation identifies with RQ1 the far-reaching implications and specific challenges of adopting agile practices and structures. *Article II* identifies which functions and processes at enterprises are especially affected by the introduction of agile practices and structures. For practitioners, these results help to identify functions and processes requiring specific attention while introducing agile practices and structures and, thus, to anticipate implications and allowing for an early mitigation of implementation risks. *Article III* contributes by revealing the implications and benefits of applying agile practices to the sourcing and contracting of large-scale IT projects and provides insights into how contract uncertainty could be reduced by applying agile practices to contracts. *Article IV* and *V* provide models for agile forms of organizational design that may serve as a template for established companies considering to adopting an agile form of organizational design. Furthermore, the identified migration paths and findings related to the case study companies help other companies avoiding potential pitfalls and thus might help regarding a smoother transition towards an agile organization. *Article VI* reveals managerial recommendations on how to increase agility and on how to manage time complexity by applying scaled agile practices. Finally, *Article VII* identifies concrete measures on how speed and flexibility can be increased in the sourcing and contracting of large IT projects and how contractual uncertainty can be reduced by the adoption of agile practices to IT sourcing and contracting.

4.3 Research Limitations and Future Research

The results of this dissertation do not come without limitations. Most notably, due to the exploratory nature of most contributions, results depend very much on insights derived from case studies. Consequently, I cannot claim that the implications of adopting agile practices and structures at established enterprises have been explored exhaustively.

Furthermore, the widespread adoption of agile practices and structures at established enterprises is a comparably recent phenomenon and most companies analyzed in case study projects of this dissertation were still implementing agile practices and structures during research. Consequently, the presented agile structures are snapshots of the current state of agile transformation during time of research with a high likelihood that adopted agile forms of organizational design will be further modified and enhanced over time.

Finally, results from case studies presented in papers of this cumulative dissertation might not be fully representative for companies of all industries or sizes and derived insights potentially suffer regarding generalizability. Therefore, generalizing the findings to a further extent requires additional research to prove that the results of this dissertation also hold true in different contexts and industries.

Future research on agile practices and structures at enterprises should focus on a longitudinal perspective to observe how the adopted agile practices and structures change over time. Furthermore, due to an early large-scale adoption of agile practices and structures at established enterprises, most cases were still IT departments or business departments in the technology or engineering segment in the larger context of ISD. The adoption of agile practices and forms of organizational design outside ISD context or at business units was at the time of research for this dissertation just at the beginning and should be pursued further. Likewise, the specific challenges and hurdles resulting from agile units cooperating with non-agile units like controlling, finance, or human resources seem to be especially relevant for future research from a practitioners' perspective.

Despite the imposed challenges, my empirical results indicate that the adoption of agile forms of organizational design is more than a short-term, transitory trend and will play a significant role as companies need to increase speed and flexibility to innovate with new digital products and services. It remains striking to learn how agile forms of organizational design will be adopted by enterprises in IT and in business units as they move from "doing agile" to "being agile".

5. Reference Overview of Articles in this Dissertation

This section provides the full bibliographical information of the articles included in this dissertation. They jointly address the formulated research objective and form the core part of the dissertation. Articles I to VII are presented in full in Part B of this dissertation.

5.1 Article I: Digital Transformation and IT: Current State of Research

Title	Digital Transformation and IT: Current State of Research
Authors	Gerster, D.
Outlet	Proceedings of the 21st Pacific Asia Conference on Information Systems (PACIS), Langkawi, Malaysia
Year	2017
Status	Published

Figure 2. Bibliographic Information for Article I

Abstract. Digital transformation not only affects business, but also IT. While digital transformation and digital technologies are well established research areas, the implications of digital transformation on IT are rarely in focus. Taking this topic as a reference, the paper contributes to general IS research by assessing to which extent digital innovation is already subject to mainstream IS research. A bibliometric study analyzing all 2,833 articles published in the AIS Senior Scholars' 'basket' of eight leading IS journals between 2007 and 2016 reveals that a mere 0.2% address the impact of digital transformation on IT while 2.3% cover topics of digital transformation, innovation, or digital technologies. In contrast to previous work, this study finds that digital innovation research is already present in primarily high-ranked IS journals.

Keywords: Digital innovation, digital transformation, digital technologies, impact on IT, bibliometric study, digital research agenda, IS research agenda

5.2 Article II: "Agile Meets Non-Agile": Implications of Adopting Agile Practices at Enterprises

Title	"Agile Meets Non-Agile": Implications of Adopting Agile Practices at Enterprises
Authors	Gerster, D., Dremel, C., Kelker, P.
Outlet	Proceedings of the 24th Americas Conference on Information Systems (AMCIS), New Orleans, USA
Year	2018
Status	Published

Figure 3. Bibliographic Information for Article II

Abstract. The question of how to increase speed and flexibility in times of digital disruption is essential to virtually any company. While previous research focuses on agility as software development practice or as form for organizing startups, little knowledge exists about agility at enterprises and its implications. Agile practices are currently adopted at enterprises in large-scale. While first steps towards agility are made quickly, we observed that specific challenges emerge when enterprises adopt agile practices. Drawing on results of an exploratory study with ten global companies and on socio-technical systems theory, we reveal that adopting agile practices has far-reaching implications on products, processes, technology, people, and structure. This study contributes to agility research with specific insights on enterprise agility and its implications. While enterprises need to increase speed and flexibility to master digital transformation, an early incorporation of the implications of adopting agile practices fosters its sustainable implementation.

Keywords: Agility, agile practices, digital transformation, enterprise agility, IT-agility

5.3 Article III: Agile Contracts: Learnings from an Autonomous Driving Project

Title	Agile Contracts: Learnings from an Autonomous Driving Project
Authors	Gerster, D., Dremel, C.
Outlet	Proceedings of the 27th European Conference on Information Systems (ECIS), Stockholm, Sweden
Year	2019
Status	Published

Figure 4. Bibliographic Information for Article III

Abstract. New digital services and products rely heavily on digital technologies and need to be deployed in an ever-shorter timeframe in response to rapidly changing market demands. To address this challenge, more and more companies are applying agile practices to increase speed and flexibility. In consequence, companies review their sourcing strategies to shorten the duration of tenders for large-scale IT projects and to increase flexibility in contracting of IT services to cope with the anticipated consequences of digital transformation. This study aims at revealing how agile practices could help to re-duce time-to-market and to increase contract flexibility. As the automotive industry is especially affect-ed by the adoption of new digital technologies, this revelatory case study shows how a German car manufacturer increased agility in sourcing and contracting of an autonomous driving development platform. Agile practices turned out to be essential in dealing with technological novelty and hurdles, regulatory uncertainty, and frequently changing requirements. We contribute to the extant knowledge by providing practical recommendations on how to increase agility in sourcing and contracting of large-scale IT projects.

Keywords: IT sourcing, agile sourcing, agile contracts, autonomous driving

5.4 Article IV: Scaling Agility: How enterprises adopt agile forms of organizational design

Title	Scaling Agility: How enterprises adopt agile forms of organizational design
Authors	Gerster, D., Dremel, C., Kelker, P.
Outlet	Proceedings of the 39th International Conference on Information Systems (ICIS), San Francisco, USA
Year	2018
Status	Published

Figure 5. Bibliographic Information for Article IV

Abstract. The question of how to increase speed and flexibility in times of digital disruption is essential to almost any company. While previous research mainly addresses agility in the context of software development, as form for organizing startups or "born digital" companies, little knowledge exists about agility at enterprises. With an exploratory study of ten global cases, this paper aims at examining how enterprises adopt and scale agile forms of organizational design. Our preliminary results reveal that (1) agile forms of organizational design are currently adopted by enterprises at large scale and successively replace bimodal IT structures where agile and non-agile units coexist in parallel, (2) Spotify's organizational design serves as a widely used template for a fully agile unit, and (3) enterprises fine-tune this template to their needs and scale.

Keywords: Agile organization, agile transformation, bimodal IT, enterprise agility

5.5 Article V: How Enterprises Adopt Agile Forms of Organizational Design: A Multiple-Case Study

Title	How Enterprises Adopt Agile Forms of Organizational Design: A Multiple-Case Study
Authors	Gerster, D., Dremel, C., Brenner, W., Kelker, P.
Outlet	*ACM SIGMIS Database: The DATABASE for Advances in Information Systems (Vol. 51, Issue 1 – February 2020)*
Year	2020
Status	Published

Figure 6. Bibliographic Information for Article V

Abstract. The question of how to increase speed and flexibility in times of digital disruption is essential to almost any company. While previous research mainly addresses agility in the context of information systems development, as form for organizing startups or "born digital" companies, little knowledge exists about the adoption of agile practices and structures at established enterprises. With an exploratory study of fifteen global cases, we aim at examining how established enterprises adopt and scale agile forms of organizational design. We found that (1) agile forms of organizational design are currently adopted by enterprises at large scale, (2) agile forms of organizational design are adopted not only by IT, but successively also by business units and in context outside information systems development, and (3) while Spotify's organization serves as a widespread template for a fully agile unit, enterprises adapt and fine-tune this template according to their needs and scale. We identified three additional models for fully agile forms of organizational design where a fully agile unit with cross-product support is the most frequently observed model.

Keywords: Agile Organization; Agile Practices; Agile Transformation; Bimodal IT, Enterprise Agility

5.6 Article VI: Managing Time Complexity with Agility: How More Considered Thinking about Time Helped Fujitsu to Set a Guinness World Record

Title	Managing Time Complexity: How More Considered Thinking about Time Helped Fujitsu to Set a Guinness World Record
Authors	Gerster, D., Dremel, C., Mayer, R. Conboy, K., vom Brocke, J.
Outlet	MIS Quarterly Executive
Year	-
Status	2nd revision resubmitted

Figure 7. Bibliographic Information for Article VI

Abstract. Digital transformation creates pressure on established enterprises as they need to increase speed and flexibility in order to respond to rapidly changing market environments. To master digital transformation challenges, organizations are increasingly turning to 'high speed' methods such as *flow* and *agile*. We argue that the differentiating feature of these methods is how they address time to achieve speed, epitomized by terms such as *cycle time*, *lead-time*, *latency*, *real-time*, and *velocity*. We examine how Fujitsu succeeded in managing time complexity in its innovation process, setting a Guinness World Record with the largest animated tablet PC mosaic by managing multiple facets of time with the help of selective agile practices. We compare our findings with four other cases confirming that scaled agile practices at their core can help in managing time complexity.

Keywords: Agile practices, agility, digital transformation, temporal complexity, time concepts

5.7 Article VII: How Digital Transformation Impacts Sourcing: Learnings from an Autonomous Driving Case

Title	How Digital Transformation Impacts Sourcing: Learnings from an Autonomous Driving Case
Authors	Gerster, D., Dremel, C.
Outlet	Proceedings of the 14th Global Sourcing Workshop (Obergurgl, Austria), Springer
Year	2020
Status	Accepted for publication in conference proceedings edited by Springer

Figure 8. Bibliographic Information for Article VII

Abstract. New digital services and products rely heavily on digital technologies and need to be deployed in an ever-shorter timeframe in response to rapidly changing market demands. To address this challenge, more and more companies apply agile practices to increase speed and flexibility. In consequence, companies review their sourcing strategies to shorten tender duration for large-scale IT initiatives and to increase flexibility in contracting of IT services to cope with the anticipated consequences of digital transformation. This study aims at revealing how the application of agile practices impacts the sourcing and contracting of IT services. As the automotive industry is especially affected by the adoption of new digital technologies, this revelatory case study shows how the German premium car manufacturer CarCo increased agility in the sourcing and contracting of IT services for an autonomous driving development IT platform. Agile practices turned out to be essential in dealing with technological novelty and hurdles, regulatory uncertainty, and frequently changing requirements. Applying agile practices to IT sourcing has two major implications: First, agile practices aim at reducing tender duration, decreasing pre-contractual uncertainty, and therefore increasing speed and flexibility. Second, agile software development changes contract nature as comprehensive requirements are replaced by high-level specifications focusing on business outcomes. We contribute to the extant knowledge on IT sourcing and contracting by providing managerial recommendations on how to increase agility in sourcing and contracting of large-scale IT initiatives.

Keywords: IT sourcing, agile sourcing, agile contracts, agile practices, autonomous driving

Part B – Constituent Articles of this Dissertation

I: Digital Transformation and IT: Current State of Research

Title	Digital Transformation and IT: Current State of Research
Authors	Gerster, D.
Outlet	Proceedings of the 21st Pacific Asia Conference on Information Systems (PACIS), Langkawi, Malaysia
Year	2017
Status	Published

Figure 9. Bibliographic Information for Article I

Abstract. Digital transformation not only affects business, but also IT. While digital transformation and digital technologies are well established research areas, the implications of digital transformation on IT are rarely in focus. Taking this topic as a reference, the paper contributes to general IS research by assessing to which extent digital innovation is already subject to mainstream IS research. A bibliometric study analyzing all 2,833 articles published in the AIS Senior Scholars' 'basket' of eight leading IS journals between 2007 and 2016 reveals that a mere 0.2% address the impact of digital transformation on IT while 2.3% cover topics of digital transformation, innovation, or digital technologies. In contrast to previous work, this study finds that digital innovation research is already present in primarily high-ranked IS journals.

Keywords: Digital innovation, digital transformation, digital technologies, impact on IT, bibliometric study, digital research agenda, IS research agenda

I.1 Introduction

Information Systems (IS) have never been more important as digital technologies are essential for business model innovation by developing new digital products and services. The increasing diffusion of digital technologies is ultimately changing our everyday lives (Yoo, 2010); businesses across industries experience quickly changing demands

(Priem, Butler, & Li, 2013). Digital transformation refers to a process of major change to enhance customer experience and to innovate on business models by leveraging digital technologies like analytics, cloud computing, internet of things, mobile, or social media (M. Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014). Companies develop new products and services with the help of new combinations of digital and physical components in order to stay competitive in the digital era (Yoo, 2010). Digital transformation has particularly major impact on IT (Urbach, 2016): Chief Information Officers (CIOs) are increasingly riddled with ambiguity (Peppard, Edwards, & Lambert, 2011) and CIO activities are expanding from providing IT services to including external customer responsibilities, working with non-IT colleagues, and managing enterprise processes (Weill & Woerner, 2013). Consequently, IT plays a key role in driving innovation but is also heavily affected by digital transformation.

Publications on digital innovation research including aspects of transformation or technology are already covered well by practitioner literature and increasingly by scientific literature. However, research related to the impact of digital technologies on IT addressing questions on the future role of the IT function or how to make an IT department future-proof for the digital economy is still rare (Horlach et al., 2016; Sørensen & Landau, 2015). An explanation might be that IS research traditionally has not focused on managerial questions related to the IT function. However, digital transformation currently receives a high attention not only in the CIO community, but also in science and is already well-present on almost any IS-conference or in special issues of IS journals.

This paper addresses the question to which extent digital innovation research and specifically research related to the impact of digital transformation on IT is already present on the mainstream IS research agenda. The impact of digital transformation on IT is taken as an exemplary reference for digital innovation research. Referring to the publications of Sørensen and Landau and Horlach et al. on digital innovation research, this paper contributes to the debate in IS on its role, status, research contributions, and relevance for practice (Grover & Lyytinen, 2015; King & Lyytinen, 2006; Lyytinen & King, 2006; Sørensen & Landau, 2015). Specifically, in times of digital transformation disrupting virtually any industry with new possibilities offered by digital technologies, the IS community needs to take a clear stance regarding its role and contributions to digital innovation research.

This paper presents the findings of a bibliometric study on the extent to which digital innovation research and specifically research regarding the impact of digital

transformation on IT is already subject to rigorous academic discussion within the AIS Senior Scholars' 'Basket of eight' leading IS journals ("Basket of eight"). The paper refers to the work of Sørensen and Landau (Sørensen & Landau, 2015) and Horlach et al. (Horlach et al., 2016) who have analyzed digital innovation research. Taking topics of mobile Information and Communications Technology (ICT) (Sørensen and Landau) and "bimodal IT" (Horlach et al.) as a reference, a significant gap in attention on topics of digital innovation between science and practice has been identified by Sørensen and Landau.

This bibliometric study reveals that a mere 0.2% of all 2,833 articles published in the "Basket of eight" between 2007 and 2016 address the impact of digital transformation on IT while 2.3% deal with digital innovation research like digital transformation, digital strategy or digital technologies. Contrary to the research of Sørensen and Landau, this study finds that digital topics have been covered recently primarily by highly ranked US journals.

This paper contributes to IS research in three ways: First, to assess to which extent topics of digital innovation research in general and specifically regarding the impact of digital transformation on IT are already covered by mainstream IS research. Second, to assess of whether the findings of Sørensen and Landau related to digital innovation research are still valid and which recent trends for 2015 and 2016 can be identified. Third, to contribute to the discussion of the current and future role of IS with respect of digital innovation research.

This paper proceeds as follow: Section 'Current State of the IS Research Agenda' gives a brief overview of the discussion on IS research. Section 'Digital Innovation Research' and 'Research on the Impact of Digital Transformation on IT outside the "Basket of Eight"' presents the current state of topic coverage. The section 'Methodology' describes the applied research methodology. Section 'Results' presents the findings from the bibliometric study and section 'Discussion' concludes the findings.

I.2 Current State of the IS Research Agenda

According to Agarwal and Lucas, IS would be predestined to conduct research on the transformational impact of IT due to the rapid change of information technology (Agarwal & Lucas Jr, 2005). IS would have to tell a "powerful story about the transformational impact of information technology" (Agarwal & Lucas Jr, 2005, p. 381). Lyytinen and King see that IS would struggle with itself about the question of its legitimacy (Lyytinen & King, 2004). Anxiety about "IS's purported lack of academic

legitimacy" would be the consequence (King & Lyytinen, 2004, p. 539). Therefore, IS would be more concerned about rigor than relevance resulting in a lack of analyzing topics of practical relevance (Benbasat & Zmud, 1999; Hambrick, 2007). Lyytinen argues that IS would critically hinge upon technological development (Lyytinen, 1999). Understanding the dynamic of digital technologies and digital transformation would necessitate IS research to cover topics like digital infrastructures (Tilson, Lyytinen, & Sørensen, 2010).

As a response, calls for a new IS research agenda to include digital technology adequately can be observed: Yoo argues to "expand our research domain by embracing the ubiquitous impact of computing in everyday life" (Yoo, 2010, p. 217). He sees a need to develop "new theoretical models and insights that guide management practices in the age of generativity" (Yoo, 2013, p. 227). Tilson et al. propose new directions for IS research as well: They recommend focusing research on topics of digital infrastructure and aspects of "paradoxes of change and control" (Tilson et al. 2010, p. 748). A more recent paper from Grover and Lyytinen postulates that scholars should be more open towards practices permitting a richer theorizing by "being bolder in our theorizing and more innovative and rigorous in our treatment of data" (Grover & Lyytinen, 2015, p. 271). Consequently, it can be assumed that digital innovation research will be increasingly present on the IS research agenda.

I.2.1 Digital Innovation Research

Digital innovation research is already an established field of IS research as the following brief overview shows: Lucas and Goh conduct a case study why Kodak missed the transformation to digital photography (Lucas & Goh, 2009). Building on Christensen's disruptive innovation theory, Kaltenecker et al. (Kaltenecker, Hess, & Huesig, 2015) examine the disruptive change for software companies while transforming from on premise to on-demand. Nolan et al. conduct a case study on the development of an aircraft, Boeing's 'Dreamliner' 787 and highlight the organizational implications of technological change in context of product innovation (Nolan, 2012). More related to the IT function, Grisot et al. focus on innovation in infrastructure (Grisot, Hanseth, & Thorseng, 2014) while Lyytinen et al. analyze the impact of product innovation on knowledge creation and sharing in innovation networks (Lyytinen, Yoo, & Boland Jr, 2016). Aubert et al. look at innovation in the outsourcing context (Aubert, Kishore, & Iriyama, 2015).

Dynamic capabilities play an important role to flexibly react to an increasingly rapid changing environment: Karimi et al. focus on the role of dynamic capabilities in responding to digital disruption with a comprehensive case study about the newspaper industry (Karimi & Walter, 2015). Pavlou et al. perceive dynamic capabilities as a source of competitive advantage (Pavlou & El Sawy, 2010) while El Sawy et al. describe digital transformation as a "messy, complex, and chaotic phenomenon" consisting of a simultaneous increase in environmental turbulence, speed of organizational change, and the intensified ubiquity of digital technologies (Omar A El Sawy, Malhotra, Park, & Pavlou, 2010).

The concept of organizational ambidexterity complements dynamic capabilities theory and postulates to build up different skills. O'Reilly and Tushman perceive organizational ambidexterity as a dynamic capability to resolve Christensen's Innovators Dilemma (O'Reilly & Tushman, 2008). Garcia-Lillo and O'Reilly and Tushman provide comprehensive overviews on literature regarding organizational ambidexterity in context of digital transformation (Garcia-Lillo, Ubeda-Garcia, & Marco-Lajara, 2016; O'Reilly & Tushman, 2013). More related to IT, the concept of contextual ambidexterity developed by Gibson and Birkinshaw provide a well-fitting theoretical concept to the practitioners' notion of "bimodal IT" (Gibson & Birkinshaw, 2004).

The software development method 'agile' has a long tradition within IS and is now understood by practitioners as a more general concept to increase flexibility in IT. While Cram et al. perceive 'agile' as a management fashion (Cram & Newell, 2016), some articles deal with the transformation of an organization to become fully agile: Lowry et al. examine on how to make an organization agile through IT (Lowry & Wilson, 2016), Kniberg et al. look at success factors of Spotify's fully agile organization (Kniberg, 2012). Rigby et al. elaborate on the key elements when 'agile' is applied to organizations (Rigby, Sutherland, & Takeuchi, 2016). However, an application of 'agile' to structure and governance of IT has not taken place so far to the best knowledge of the author.

Quite many publications deal with digital innovation and digital strategy: Bharadwaj et al. address aspects of scope, scale, speed, and source for a digital strategy (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). El Sawy et al. describe how Lego has transformed its business model towards digital leadership (Omar A. El Sawy, Kræmmergaard, Amsinck, & Vinther, 2016). Hansen and Sia look at Hummel's digital strategy (Hansen & Sia, 2015) and Hess et al. develop options for formulating a digital strategy based on three cases in the media industry (Hess, Matt, Benlian, & Wiesböck, 2016).

These examples on digital innovation research show that digital strategy and digital transformation are already well present on the scholar IS research agenda.

I.2.2 Research on the Impact of Digital Transformation on IT outside the "Basket of Eight"

While digital transformation significantly impacts IT, research related on how to make an IT organization future-proof for effectively providing digital technologies is still rare. Even though not focused by IS research, managerial or structural aspects of the IT function are well present. Consequently, the question arises on how digital transformation impacts these topics and of whether existing concepts and recommendations need to be adapted.

The following section focuses research on the impact of digital transformation outside the "Basket of eight". Related publications within the "Basket of eight" are presented in the 'Results' section.

Horlach et al. show in a comprehensive literature review on "bimodal IT" that just one scientific publication exists as of August 2015 while there is a wide range of publications in practitioner literature (Horlach et al., 2016). "Bimodal IT" refers to the coexistence of traditional IT with digital IT implying that an IT organization needs to manage both for successfully managing the digital transformation and relies on the concept of organizational ambidexterity.

Bygstad's paper "The Coming of Lightweight in IT" is according to Horlach et al. the first academic paper on "bimodal IT" and applies the concepts of generativity and loose coupling to "bimodal IT" (Horlach et al., 2016). According to Bygstad, "heavyweight IT" refers to traditional systems and databases that become more sophisticated and expensive as they become more integrated with other systems (Bygstad, 2015). Contrary, "lightweight IT" would be the new paradigm of mobile apps, sensors and bring-your-own-device, also called consumerization or internet of things. Both modes need to be connected without hindering the generative attributes of each other (Bygstad, 2015).

Haffke et al. deal with aspects of "bimodal IT" and extend Bygstad's work to questions of the organizational structure. Based on IT executive survey data they analyze how "bimodal" structures are implemented in IT organizations. One of the key findings is that "bimodal IT" would serve as a transition state towards a fully agile IT organization (Haffke et al., 2017b).

I.3 Methodology

This paper conducts a bibliometric study on all articles published between January 2007 and December 2016 in the AIS Senior Scholars 'basket' of eight leading IS journals. The empirical analysis of articles published in leading IS journals is an established method of studying IS research (Chen & Hirschheim, 2004; Grover & Lyytinen, 2015; Sørensen & Landau, 2015). The "Basket of eight" has been selected in order to have a representative sample for journals of high reputation among IS scholars focusing on mainstream IS research. Objective is to analyze to which extent digital innovation research in general and specifically related to the impact of digital transformation on IT is already covered by leading IS journals.

This paper applies Sørensen and Landau's methodology (Sørensen & Landau, 2015) to recent digital innovation research. An accompanying literature search on relevant 'digital' literature has been conducted according to vom Brocke et al. and Webster and Watson (Vom Brocke et al., 2009; Webster & Watson, 2002).

The limitation on the "Basket of eight" as representative journals for mainstream IS research can be criticized for good reasons and has been subject to discussions in the IS community (Leslie Willcocks, Whitley, & Avgerou, 2008). Consequently, the analysis excludes publications in other IS or interdisciplinary journals, IS conferences, or dissertations.

The limitation on the "Basket of eight" has been chosen besides of reasons for methodological consistency with Sørensen and Landau for three reasons: First, the "Basket of eight" reflects a representative sample for 'mainstream' scholar IS research due to its high acceptance in the IS community. This is because the scientific debate is mainly conducted through peer-reviewed journal publications (Galliers & Whitley, 2007; Stein, Galliers, & Whitley, 2016; Leslie Willcocks et al., 2008). While newer research topics are often discussed on conferences and topics related to managerial or operational aspects of technology can be found predominately in journals targeting a practitioner audience, the "Basket of eight" serves as a well-established indicator on how new topics become part of the mainstream scholar research agenda. According to Sørensen and Landau "including outlets relying less on a rigorous peer review process many undoubtedly have demonstrated speed in exploring new phenomena but would not have allowed the study of both speed and rigor" (Sørensen & Landau, 2015, p. 162). Second, the "Basket of eight" is a representative choice for journals covering the scholar IS discussion since all are international journals provide a representative regional coverage with four journals from the US (ISR, JAIS, JMIS, and MISQ) and four journals

from Europe (EJIS, ISJ, JSIS, and JIT). Third, the "Basket of eight" consists of journals focusing on IS topics only.

The "Basket of eight" consists of the following journals (alphabetically ordered):

- European Journal of Information Systems (EJIS, ISSN: 0960-085X);
- Information Systems Journal (ISJ, ISSN: 1365-2575);
- Information Systems Research (ISR, ISSN: 1047-7047);
- Journal of Information Technology (JIT, ISSN: 0268-3962);
- Journal of Management Information Systems (JMIS, ISSN: 0742-1222);
- Journal of Strategic Information Systems (JSIS, ISSN: 0963-8687);
- Journal of the Association of the AIS (JAIS, ISSN: 1536-9323);
- MIS Quarterly (MISQ, ISSN: 2162-9730).

The bibliometric study takes the number of published articles as a measure for the extent of research on the phenomenon within mainstream IS discussion. Essentially, it counts all relevant articles published in the "Basket of eight" related to digital innovation in general and specifically to the impact of digital transformation on IT. If the article seemed to be relevant, the paper has been downloaded for further examination regarding relevance. Research articles, guest editorials, introductions to a journal's special issue, research notes, and research commentaries have been included. General editorial notes, book reviews, errata, responses to previous publications, teaching cases, author index, research index, and acknowledgements have been excluded from the count since these publication types are usually not used for communication of new research results.

Digital transformation is mainly prevalent in the CIO discussion since the emergence of digital technologies. The time frame of the bibliometric study has been limited for this reason to the last ten years, specifically from January 2007 to December 2016. The limitation regarding the time frame can be justified with the finding that the majority (81%) of all identified articles has been published between 2012 and 2016 whereas just 19% of all identified articles have been published between 2007 and 2011. Just three articles at all could be identified between 2007 and 2009.

Identified articles have been classified for relevance according to the following criteria: All articles directly addressing the topic of the impact of digital transformation on IT have been classified as "relevant". Examples include articles covering topics of digital technologies or digital transformation in context with IT. Articles related to either the topic of digital transformation, digital strategy, digital technologies but not in context with the IT function have been classified as "partly relevant". Examples include articles

on digital technologies like business analytics or cloud computing, digital strategy, or on the future role of the CIO.

This bibliometric study differs from Sørensen and Landau's work in three minor respects: First, this study has a slightly wider definition of articles included. Sørensen and Landau exclude guest editorials and introductions to special issues. This study has taken them into account since they contain opinions or contributions relevant for further development of research. Second, this bibliometric study classifies articles as "relevant" or "partly relevant". This distinction has been made because of the low number of identified relevant articles. The category "partly relevant" has been introduced to take a wider range of articles into account that are also related to digital transformation and digital technologies in general. Therefore, unlike Sørensen and Landau, this paper does not restrict digital innovation research to a comparatively strict definition like mobile ICT, but also takes various aspects of digital innovation, digital strategy, and digital technologies into account. Third, this study uses a different, more recent time frame of 2007-2016, whereas Sørensen and Landau have used the time frame between 2000 and 2014. As already mentioned, the vast majority of relevant and partly relevant articles has been published as of 2012.

I.4 Results

A bibliometric study analyzing all articles published in the "Basket of eight" between 2007 and December 2016 has been conducted for identifying to which extent digital innovation research is already covered by leading IS journals.

An examination of titles, abstracts, and key words of all 2,833 articles published in the "Basket of eight" between January 2007 and December 2016 has retrieved five articles covering the aspects of the impact of digital transformation on IT. These articles have been classified as "relevant". Additional 64 articles have been identified that cover general topics of digital transformation, digital strategy, or digital technologies but not related to IT. These articles have been classified as "partly relevant". Relevant and partly relevant articles account for a total of 0.2% respectively 2.3% of all articles published in the "Basket of eight" between January 2007 and December 2016.

Year	Total [#]	Partly relevant [#]	Relevant [#]	Partly relevant as % of total	Relevant as % of total	Partly relevant % of total partly rel.	Relevant total % of total relevant
2016	277	8	2	0.3%	0.1%	12.5%	40.0%
2015	269	6	3	0.2%	0.1%	9.4%	60.0%
2014	308	8	0	0.3%	0.0%	12.5%	0.0%
2013	302	20	0	0.7%	0.0%	31.3%	0.0%
2012	338	9	0	0.3%	0.0%	14.1%	0.0%
2011	301	3	0	0.1%	0.0%	4.7%	0.0%
2010	287	7	0	0.2%	0.0%	10.9%	0.0%
2009	230	2	0	0.1%	0.0%	3.1%	0.0%
2008	258	0	0	0.0%	0.0%	0.0%	0.0%
2007	263	1	0	0.0%	0.0%	1.6%	0.0%
Total	2,833	64	5	2.3%	0.2%	100%	100%

Table 1. Articles on the impact of digital transformation on IT by year published

As can be seen from Table 1, all five relevant articles have been published in 2015 or 2016. This shows that despite of being a comparatively young topic in scholar IS research, digital innovation research related to the IT function entered the mainstream IS research agenda recently.

The publication peak of partly relevant articles is in 2013 with 20 articles representing 31.3% of all partly relevant articles. This is due to special issues in ISR and MISQ: A special issue in ISR on social media and business transformation in volume 24, issue 1 (March 2013) covers a total of five partly relevant articles. A special issue in MISQ on digital business strategy in volume 37, number 2 (June 2013) contains six partly relevant articles.

81% of all partly relevant articles have been published between 2012 and 2016 indicating that 'digital' topics have already been present also in mainstream IS journals since a couple of years. Few publications are from earlier than 2011 – 13 partly relevant articles (20%) have been published between 2007 and 2011 and just one article has been published between 2007-2008.

Table 2 shows the number of total, relevant, and partly relevant articles per journal and region.

Journal	5 year impact factor 2015 (Thomson Reuters)	Articles total [#]	Articles partly relevant [#]	Articles relevant [#]	Articles as % of total articles	Articles partly relevant as % of total	Articles relevant as % of total articles	Articles as % of all part-ly rel./ relevant articles
MISQ	9.51	499	15	0	16%	0.5%	0.0%	21.7%
ISR	4.01	454	17	2	16%	0.6%	0.1%	27.5%
JMIS	3.78	431	4	0	15%	0.1%	0.0%	5.8%
JAIS	2.73	330	5	0	12%	0.2%	0.0%	7.2%
US total	5.01	1,664	41	2	59%	1.4%	0.1%	62.3%
			1.4%	0.1%		0.0%	0.0%	
JIT	6.19	283	7	1	10%	0.2%	0.0%	11.6%
JSIS	3.49	196	4	2	7%	0.1%	0.1%	8.7%
ISJ	3.17	237	6	0	8%	0.2%	0.0%	8.7%
EJIS	3.01	453	6	0	16%	0.2%	0.0%	8.7%
EU total	3.96	1,169	23	3	41%	0.8%	0.1%	37.7%
			0.8%	0.1%				
Total BOE			64	5	100%	2.3%	0.2%	100%
			2.3%	0.2%				

Table 2. Number of publications per journal and region

As can be seen from Table 2, this bibliometric study reveals insights on the split of articles according to journal, region and impact factor:

Most identified partly relevant and relevant articles have been published in US journals (62.3 %) compared to 37.7% published in European journals.

Three out of the total of five relevant articles have been published in European journals while the other two articles have been published in US journals. Relevant articles have been published in journals with a comparably high 5-year impact factor as of 2015 according to Thomson Reuters – JIT (6.19), ISR (4.01), and JSIS (3.49).

Most identified articles have been published in high-ranked journals MISQ and ISR: The highest overall coverage of all partly relevant and relevant articles has the US-journal ISR with 27.5% - in total 17 partly relevant and two relevant articles. Within the

"Basket of eight", ISR is the third-highest ranked journal with an impact factor of 4.01. The top-ranked US-journal MISQ with an impact factor of 9.51 comes second regarding article coverage with a total of 22% of all partly relevant articles. The high article coverage in ISR and MISQ is due to special issues related to digital transformation in 2013 clearly demonstrating that 'digital' topics are on the mainstream research agenda in top ranked IS journals.

The European journal JIT comes third regarding article coverage with a total of seven partly relevant and one relevant article. JIT is the second-highest ranked journal in the "Basket of eight" with an impact factor of 6.19 and the highest-ranked journal of European origin in the "Basket of eight".

Two US journals have the overall lowest article coverage: JMIS with a total of four partly relevant articles (5.8%) and JAIS with a total of five partly relevant articles (7.2%). Of all journals in the "Basket of eight", JAIS is lowest ranked with an impact factor of 2.73. JMIS has an impact factor of 3.78.

The identified relevant articles are briefly introduced as follows: These articles cover topics of agility, innovation, or organizational ambidexterity: Gregory et al. conduct a multiyear case study to discover aspects of organizational ambidexterity in context of IT transformation programs (Gregory, Keil, Muntermann, & Mähring, 2015). They identify areas where organizational ambidexterity can be expected and give recommendations on how to handle them (Gregory et al., 2015). Lee et al. analyze the relationship between organizational ambidexterity and agility. This is one of the few articles explicitly dealing with organizational ambidexterity in context of IT. By using large-scale survey data, the authors conclude that a firm's IT ambidexterity capabilities enhance organizational agility (Lee et al., 2015). Lowry et al. deal with another aspect of organizational agility: They address the question on how organizational agility can be improved by IT. The authors develop a theoretical model relating an organization's internal IT service perceptions to IT agility and verify the hypothesis that a service perception of the internal IT positively affects IT agility (Lowry and Wilson 2016). Both, Kaltenecker et al. and Kumar et al. address topics of organizational change management: Kaltenecker et al. examine the disruptive potential of cloud computing. They apply Christensen's disruptive innovation theory and derive implications of disruptive change from 'on-premise' to 'on-demand' (Kaltenecker et al., 2015). The editorial of Kumar et al. is the introduction to a special issue titled "Exploring Enterprise Social Systems & Organizational Change: Implementation in a Digital Age" in Volume 31, issue 2 (June 2016) of JIT. The authors conduct a comprehensive literature review

on enterprise social systems and elaborate on the challenges for organizational change and the implications for IT (Kumar, Loonam, Allen, & Sawyer, 2016).

One objective of this study is to compare results with the findings of Sørensen and Landau and to assess the coverage of 'digital' innovation research as of 2015 and onwards that has not been covered by Sørensen and Landau. While this bibliometric study reveals roughly a comparable percentage of articles relevant to the selected reference topic of digital innovation research (Sørensen and Landau – mobile ICT: 3.2%; this study – impact of digital transformation on IT and related topics of digital technologies and strategy: 2.5%), the findings of this study differ quite substantially from Sørensen and Landau in three aspects: First, the finding of Sørensen and Landau that 'elite' IS journals tend to be less open towards new topics of digital innovation research (Sørensen & Landau, 2015) cannot be confirmed for the subject of this study: Major reasons are publications of all relevant articles in 2015 and 2016 and a large number of publications following the specials issues of ISR and MISQ in 2013. This implies that topics of digital innovation research find now successively their way into leading IS journals. Second, and also contrary to the findings of Sørensen and Landau, journals with a high reputation have a higher topic coverage compared to lower ranked journals: The top four ranked journals MISQ, ISR, JMIS, and JIT cover 67% of all identified articles whereas the bottom four ranked journals in the "Basket of eight", JSIS, ISJ, EJIS, and JAIS, cover 33% of all identified articles. Third, this bibliometric study finds that most of the articles identified comes from US journals (62.3%), whereas articles in European journals cover 37.7% of all identified articles. Sørensen and Landau found that most identified articles has been published in – lower ranked – European journals. An explanation would be that lower-ranked journals could be more innovative because they need to be less concerned about mainstream research (Sørensen & Landau, 2015). Since the impact factor is measured by citations in academic publications, a higher impact factor is associated with more citations indicating that the article's topic is likely to be closer to mainstream scientific research.

However, an overall 2.5% identified articles covering topics of 'digital' innovation research in the "Basket of eight" is still not much for a topic with high attention among practitioners (Urbach, 2016) and in a research field being exposed to contemporary fashions (Baskerville & Myers, 2009; Cram & Newell, 2016; P. Wang, 2010).

As additional illustration for the gap between topic attention in science and practice and following the approach of Sørensen and Landau, a cross-check for hits of specific 'digital' terms in scientific and non-scientific databases has been conducted. The insight

of such a study is limited and one could question its sense at all. It has been included in this study since the results confirm previous findings: Both, academics, and practitioners use specific terms regarding selected 'digital' topics, and they do not necessarily use the same language. But even if 'digital' search terms are used by both, scientists and practitioners synonymously, there is a significant gap between search results in scientific and non-scientific databases like Google.com: Search results in scientific databases are always significantly smaller compared to Google since academic databases do not contain advertisements or information on product or service offerings. Consequently, the absolute difference in search results for one search term across the different data bases is of limited insight. There is however a meaning if significant differences in search results across different search terms exist.

A search on selected 'digital' terms has been conducted in the databases Metasearch (https:// www.ebscohost.com), Web of Science (https://apps.webofknowledge.com), JSTOR (www.jstor.org), Google Scholar (http://scholar.google.com), and in Google (www.google.com). The search has been conducted for selected 'digital' terms like "agile" or "digital strategy" that are used in both, science and practice. A cross-check has been performed with expressions that are more common in science, like for example the term "ambidexterity", or that are mainly used in practice, like for example the term "digital disruption". Search results from scientific databases have been compared with search results from Google. Google Trends have been included for a better understanding of trend development regarding the search terms over time.

Search term	Meta-search Ebsco[1)]	Web of Science[2)]	JSTOR[3)]	Google Scholar[4)] ['000]	Google[5)] ['000]	Google search trends[6)]
"Bimodal IT"	25,014	7,659	7,654	599	3,950	Declining since mid-2016
"Two speed IT"	255,316	51,677	215,228	4,030	51,400	Constant interest with high variance
"Agile"	77,869	12,251	9,074	616	84,300	Slightly increasing interest
"DevOps"	1,252	131	2	5.62	18,000	Steady growth since 2012
"Ambidexterity"	38,320	935	443	18.6	317	Constant interest with high variance
"Digital strategy"	135,943	16,751	19,486	3,320	22,200	Constantly increasing interest
"Digital IT architecture"	6,133	7,897	9,664	2,450	473,000	Constant interest
"Digital transformation"	48,517	8,469	14,627	2,830	13,600	Strong growth since 2016
"Digital technologies"	955,088	63,595	20,848	3,320	38,900	Constant interest
"Digital disruption"	6.024	920	2,030	507	45,900	Strong growth since 2015

1) https://eds.b.ebscohost.com; 2) https://apps.webofknowledge.com; 3) www.jstor.org

4) www.scholar.google.com; 5) www.google.com; 6) www.trends.google.com

Table 3. Results of exemplary 'digital' search hits for selected databases and websites – search conducted on 20.04.2017.

As can be seen from Table 3, scientific databases return roughly similar hits for exemplary 'digital' expressions with Metasearch Ebsco returning generally more search results than Web of Science or JSTOR. Google Scholar returns significantly more hits than the three other scientific databases. Google.com returns for all search termini a multiple of search hits compared to the scientific databases. Google.com can be taken as a reference for a non-scientific database.

The following results are noteworthy:

- Some terms that are clearly used in either scientific or practice-related context: The search term "ambidexterity" returns in Google.com 'only' approx. eight times more search results compared to Ebsco Metasearch. Contrary, the search term "bimodal IT" is mainly used among practitioners with comparably few hits in academic databases whereas the corresponding scientific term "two speed IT" also returns a significant number of hits in scientific databases.
- The somehow blurred term "digital disruption" is mainly used by practitioners and not academics. Surprisingly, the term "digital transformation" has a comparatively high coverage in scientific context.
- "DevOps" is in academics in contrast to the term "agile" so far almost not present despite of being closely associated with agile methods and ambidexterity.

Figure 10 visually displays the search results from Google Scholar and Google.com for exemplary 'digital' search terms. The matrix dimensions "innovation/digitalization" and "global operational backbone" serve for reasons of better visualization. The absolute size of the bubble represents the number of search hits and can be used as a proxy for topic relevance.

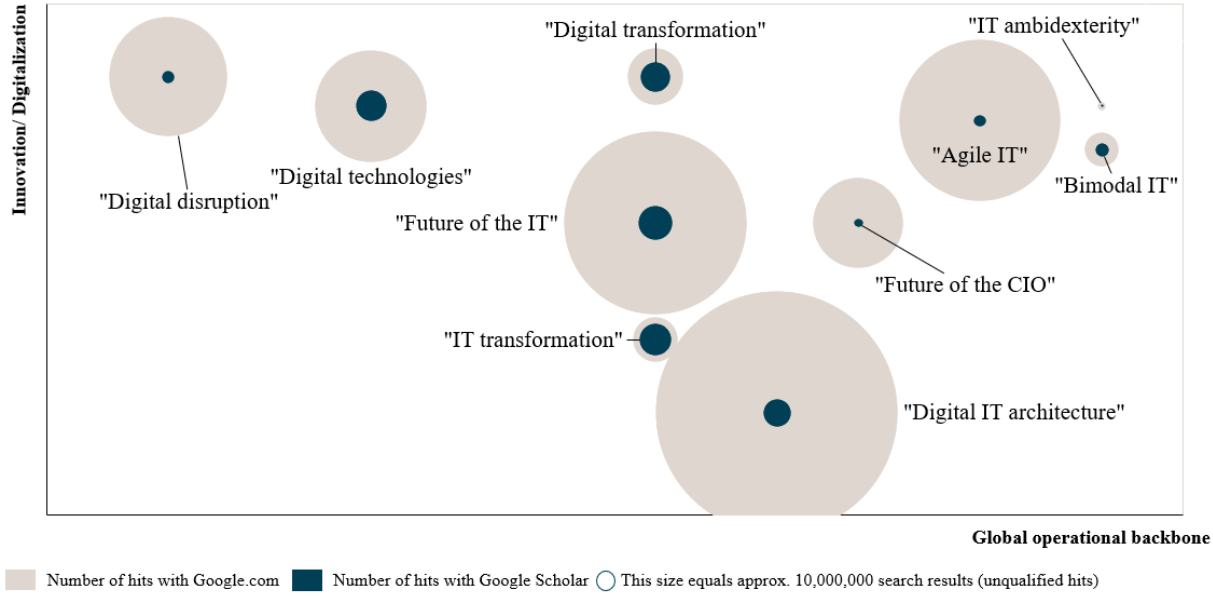

Figure 10. Search results for selected 'digital' terms at Google Scholar and Google.com – search conducted on 20.04.2017.

"Digital IT architecture" followed by "agile" retrieve most hits on Google whereas "ambidexterity" and "bimodal IT" retrieve the fewest hits on Google. Terms with

comparably similar topic coverage in academics and practice include "digital transformation", "digital strategy", or "two speed IT". "Digital disruption", "DevOps" or "agile" are comparably widespread in practice while not in academics, whereas "bimodal IT" or "ambidexterity" play only a niche role in both, science and practice.

This analysis comes with limitations: The number of unqualified hits is only a rough proxy for the quality of search results and therefore should not be overrated. Furthermore, Google.com includes search results for product and service offerings of suppliers and advertisements. Consequently, the number of search results serves only as a rough indication for topic relevance and is in vast contrast with the comparably limited number of search hits in primarily scientific databases (Horlach et al., 2016; Sørensen & Landau, 2015).

I.5 Discussion

A bibliometric study analyzing all 2,833 papers published in the "Basket of eight" between January 2007 and December 2016 has been conducted. Result is that a mere 2.5% of all articles are related to topics of digital transformation, innovation, strategy, or technologies. Just five articles (0.2%) address the impact of digital transformation on IT.

81% of all identified articles have been published since 2012 and the identified five articles addressing the impact of digital transformation on IT have been published in 2015 or 2016.

This study comes to different results regarding latest publication trends compared to Sørensen and Landau: Contrary to their findings, the majority of all identified articles (62.3%) has been published in journals of US origin. Also contrary to Sørensen and Landau, most of all identified articles has been published in high-ranked journals – MIS Quarterly, ISR and JIT cover altogether 60.9% articles. Consequently, Sørensen and Landau's finding that 'elite' IS journals tend to be less open towards new topics of 'digital' innovation research (Sørensen & Landau, 2015) cannot be confirmed for the subject of this study.

This bibliometric study comes with the limitation that the "Basket of eight" has been chosen as empirical context. Reason is that the "Basket of eight" enjoys a high acceptance among researchers, it focuses on IS topics exclusively and it has a representative regional coverage with four US and four European journals. Due to a comparatively high impact factor of the journals, the "Basket of eight" serves as a

representative and valid indicator for the degree to which new topics like digital innovation have already become part of the mainstream IS research agenda.

Extending the bibliometric study to journals outside the "Basket of eight" would confirm the hypothesis that journals focusing practitioners or a general business audience have a higher topic coverage: MIS Quarterly Executive has a stunning overall topic coverage of 29.5% with 12 relevant and 39 partly relevant articles between 2007 and 2016. The German journal 'HMD – Praxis der Wirtschaftsinformatik' has a total of 10.1 % partly relevant or relevant articles out of all 348 published articles between 2012 and 2016. MIT's Sloan Management Review targeting a more general business audience comes to an impressive 23.8% of partly relevant articles out of the 294 articles published between 2012 and 2016 covering all different aspects of digital strategy, innovation, and technology. With respects to conferences, ICIS as an example for a highly ranked IS conference has an impressive topic coverage of 25.3% in 2016.

This bibliometric study has implications for future research and for the role of IS research in general: For future research, an extension of the analysis beyond the "Basket of eight" with selected focus e.g. on practitioner-related journals or conferences only could provide additional insights on the early stage of adapting digital innovation research and on how new topics find their way in the mainstream IS research agenda. Furthermore, since articles in high-ranked journals have a longer lead time for publication because of more extensive review-cycles, it would be interesting to learn on how topic coverage evolves in the future. More recent trends regarding coverage of digital innovation topics within the "Basket of eight" are very encouraging: The highest-ranked journal in the "Basket of eight", MIS Quarterly, has published three partially relevant and one relevant article in just one edition in 2017 (Vol. 41, No. 1, March 2017).

For the role of IS research in general, this study should encourage IS researchers to engage in digital innovation and to further contribute to the discussion and knowledge creation regarding digital innovation topics: The current attention of the digital transformation among practitioners could be used as backwind for further strengthening IS research. As the IT department of a company is predestined to contribute to digital transformation of a company by providing digital technologies for business model innovation with the help of new digital products and services, IS research is predestined to contribute by applying relevant theories to generate further insights likewise. As an example, Bygstad et al., Horlach et al., and Haffke et al. have been the first to address the topic of "bimodal IT" (Bygstad, 2015; Haffke et al., 2017b; Horlach et al., 2016). But many questions remain like how "agile" and "bimodal IT" are related to

organizational ambidexterity or of whether DevOps can be seen as a lever for achieving contextual ambidexterity. Furthermore, there is a need to analyze how digital transformation affects existing IS theories, concepts and models that mainly stem from the "pre-digital age". For instance, digital technologies like cloud computing or the internet of things have significant impacts on how software development, operations and service management will be conducted. However, existing IT management models like ITIL or COBIT currently do not reflect implications of digital technologies.

IS research having the tools and methods to make an important contribution to digital transformation. Design Science Research or Design Thinking are just some examples: Both are suitable for analyzing complex or wicked problems like digital transformation and have the power to create useful artifacts of both, practical relevance and theoretical impact. Now IS has to deliver if it does not want to be in the same situation like many IT departments today: Business does not need IT anymore because digital technologies have made business units independent from IT as an exclusive gateway to technology (Urbach, 2016). Recent publications on digital innovation research especially in highly ranked IS journals within the "Basket of eight" are very promising – yet more need to come.

II: "Agile Meets Non-Agile": Implications of Adopting Agile Practices at Enterprises

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Outlet	Proceedings of the 24th Americas Conference on Information Systems (AMCIS), New Orleans, USA
Year	2018
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Figure 11. Bibliographic Information for Article II

Abstract. The question of how to increase speed and flexibility in times of digital disruption is essential to virtually any company. While previous research focuses on agility as software development practice or as form for organizing startups, little knowledge exists about agility at enterprises and its implications. Agile practices are currently adopted at enterprises in large-scale. While first steps towards agility are made quickly, we observed that specific challenges emerge when enterprises adopt agile practices. Drawing on results of an exploratory study with ten global companies and on socio-technical systems theory, we reveal that adopting agile practices has far-reaching implications on products, processes, technology, people, and structure. This study contributes to agility research with specific insights on enterprise agility and its implications. While enterprises need to increase speed and flexibility to master digital transformation, an early incorporation of the implications of adopting agile practices fosters its sustainable implementation.

Keywords: Agility, agile practices, digital transformation, enterprise agility, IT-agility

II.1 Introduction

Digital transformation is ubiquitous and requires companies to "rethink how they interact with customers, define value propositions, leverage data, and organize internal operations" (Joehnk et al., 2017, p. 1). Business model innovation takes place as new competitors create new products or services with the help of digital technologies (Weill & Woerner, 2015). Thus, digital transformation imposes the need to react to rapidly changing market demands (Highsmith, 2009). The question of how to increase agility plays a crucial role as companies compete on new combinations of digital and physical components for product innovation (Yoo et al., 2010). The pervasive adoption of agile practices (Kurapati, Manyam, & Petersen, 2012) provides evidence for the need of speed and flexibility (B. Fitzgerald & Stol, 2017).

While first steps towards agility are made quickly, we have observed that enterprises soon realize that adopting agile practices differs significantly from a startup or greenfield context. Contrary to startups, enterprises are exposed to massive, highly customized legacy infrastructure, high volumes of historic data, well-established, highly efficient and optimized business processes that are difficult to change, and require an orchestration with multiple stakeholders (Kulak & Li, 2017). As "agile breaks everything" (Kulak & Li, 2017, p. 15), adopting agile practices has far-reaching implications on a company's work system (i.e., actors, structures, technologies, and tasks) (Bostrom & Heinen, 1977).

Current research focuses on agility as a method of software development (Fitzgerald and Stol 2017) or perceives agility as only suitable to small units with co-located software developers in non-safety critical context (Ambler 2001). Consequently, we have observed a lack of understanding regarding agility as a phenomenon and specifically regarding agility in the enterprise context with respect to: (1) Clarity of the term and observed kinds of agility (Conboy, 2009), (2) specifics of agility in the enterprise context and its scaling (Kettunen and Laanti 2008; Leffingwell 2007; Reifer et al. 2003), (3) implications of adopting agile practices at enterprises (Kulak & Li, 2017), (4) the applicability of the theoretical agility concept (Conboy, 2009), and (5) empirical studies on how agile practices work in reality (Abrahamsson et al., 2009).

Furthermore, agile practices are often introduced "mechanically" with frameworks like SAFe (Scaled Agile Framework) or LeSS (Large Scale Enterprise Scrum), best practices, or following recommendations from agile coaches neglecting the company specifics (Kulak & Li, 2017). As a result, enterprises frequently run into challenges

when agile units need to collaborate with existing, non-agile units since mechanical approaches lose their sustainability as the environment around them changes (Kulak & Li, 2017).

Against this backdrop we aim at doing justice to the increasing significance of agile practices for enterprises with the following research questions:

RQ1: What are the specific challenges of adopting agile practices at enterprises?

RQ2: What are the implications of adopting agile practices at enterprises?

This study is part of a larger research endeavor on enterprise agility. We have conducted a multiple-case study with ten global companies to learn about the implications of adopting agile practices at enterprises. We found that agile practices are currently adopted large-scale at well-established, traditional businesses. The cases revealed that, surprisingly, agile practices are usually adopted without an upfront profound impact analysis. Consequently, we observed specific challenges when enterprises adopt agile practices.

We contribute to research by shedding light on agility at enterprises identifying and clustering observed implications of adopting agile practices by making use of the socio-technical systems theory (STS theory) (Bostrom & Heinen, 1977). Practitioners benefit from insights on the specifics of agility at enterprises, implications of the adoption of agile practices and how leading global companies tackle these challenges.

II.2 Theoretical Background

This section provides an overview of the theoretical background relevant for this study. We refer to related research on IT and enterprise agility and the socio-technical systems theory.

II.2.1 Roots of Agility

Agility is a response to challenges with the traditional way IT is organized following "Plan-Build-Run" and especially the resulting separation between build and run (Fowler & Highsmith, 2001). Agile practices root in systems thinking and lean practices (Kulak & Li, 2017). Systems thinking is about changing our perspective to solve problems in new and unexpected ways (Deming, 2000). A key assumption of systems thinking is that success is the relation between people and practices and that trust is a prerequisite for speed and success (Kulak & Li, 2017).

The Agile Manifesto is seen as the basis for agile practices and aims at designing "better ways of developing software by doing it and helping others do it" (Fowler & Highsmith, 2001, p. 2). The Agile Manifesto is related to systems thinking and adopts its principles to software development: Individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (Fowler & Highsmith, 2001).

II.2.2 IT Agility

Due to its roots in software development, agility is closely related to IT. IT-agility can be defined as "the conceptual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value" (Conboy, 2009, p. 340). Consequently, a tighter connection between development and execution is required to ensure that errors are detected and fixed as soon as possible (B. Fitzgerald & Stol, 2017). IT agility is characterized by the following practices: Formulation of value stories, removing complexity, shortening release cycles to incorporate immediate customer feedback, and the estimation with story points to reduce effort estimation complexity (Kim, Debois, Willis, & Humble, 2016). Agile practices aim at clean code, pair programming and immediate feedback, test-driven development, continuous integration, and automated testing (Kulak & Li, 2017). However, introducing agility in the IT function alone is not sufficient and requires "a more holistic approach […] than one which is merely focused on continuous integration of software" (B. Fitzgerald & Stol, 2017, p. 176). The benefits of agile software development will be sub-optimal if not complemented by an agile approach in related organizational functions such as finance or procurement (Overby et al., 2005).

II.2.3 Enterprise Agility

As organizations scale, so do development and operations in the IT function. While they may initially be co-located with close communication links, increased team size and more strict separation of responsibilities can weaken such links (Swartout, 2014). Practitioners made attempts to scale agile practices for enterprises: LeSS (Large Scale Scrum) is a lightweight agile framework for scaling Scrum to more than one team (Larman & Vodde, 2017) and SAFe (Scaled Agile Framework) is another approach for lean agile thinking and more visibly incorporating of scalable DevOps (ScaledAgile, 2017). It is based on "experiences of organizations that have adopted agile at enterprise

scale and describes practices and activities, roles, and artefacts" (B. Fitzgerald & Stol, 2017, p. 177). We therefore define agility in the enterprise context as "an organization's ability not only to sense, but to respond swiftly and flexibly to technical changes, new business opportunities and unexpected environmental changes" (Hekkala et al., 2017, p. 5870).

II.2.4 Socio-Technical Systems Theory

The socio-technical perspective has its roots in the sociotechnical model of Leavitt (2013) and was formulated by Bostrom and Heinen (1977) to elaborate the best way to design information systems in line with the organizational work system (Bostrom & Heinen, 1977). They distinguish the technical system and the social system as constituent parts of the work system as outlined in Figure 12.

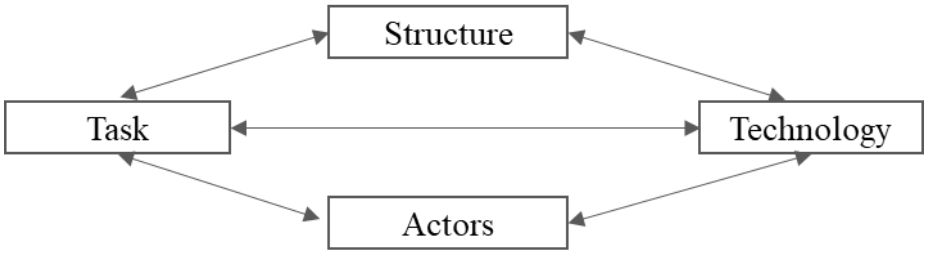

Figure 12. Socio-technical perspective on organizational work systems (Bostrom & Heinen, 1977; Leavitt, 2013)

The social system consists of structures and actors (Bostrom and Heinen 1977; Leavitt 2013). Actors include people with their culture and abilities and structures consist of "systems of communication, systems of authority (or other roles), and systems of workflow" (Leavitt 2013, p. 2978). Accordingly, actors include, besides others, organizational culture, capabilities, and knowledge whereas structures encompass organizational structures, ways of communication, and project organizations. The technical system consists of technology and tasks (Bostrom and Heinen 1977; Leavitt 2013). Tasks relate to "raison d'être [of the firm]: The production of goods and services, including the large [...] number of meaningful subtasks that may exist in complex organizations" (Leavitt 2013, p. 2977) and technology relates to "direct problem-solving inventions like work-measurement techniques or computers" including programs and machines (Leavitt 2013, p. 2977). Thus, technology constitutes of the tools and technological platforms and task represents the required organizational processes to fulfill work (Bostrom, Gupta, & Thomas, 2009; Lyytinen & Newman, 2008).

The socio-technical systems theory serves as a helpful lens for analyzing IS-induced changes in the organizational context and, particularly, its effects on the social and technical system (Lyytinen & Newman, 2008). To successfully achieve the desired system performance the successful adoption, diffusion, and use of IS systems and its practices requires to consider this interrelationship and dependency (Bostrom & Heinen, 1977). In consequence, knowledge about the alignment of socio-technical components is crucial for a profound understanding of the interdependencies at an organization (Lyytinen & Newman, 2008).

II.3 Research Methodology

This study analyzes the challenges and implications of introducing agile practices at well-established, existing companies with an exploratory multiple-case study. We adopt a multiple-case study research design to investigate "a contemporary phenomenon in depth and within its real-life context" (Yin 2009, p. 18) for three reasons: First, IS research lacks in keeping up the pace with practitioner literature regarding enterprise agility (Conboy, 2009). Second, there is often a substantial difference between the textbook "vanilla" version of a method and how it actually enacted in practice (X. Wang et al., 2012). Third, a multiple-case study design allows for cross-case analysis, which helps us to shed light on the organizational configurations that lead to and affect enterprise agility (Yin, 2009).

To avoid a potential industry bias, we selected cases from diverse industries (see Table 1). We aimed at identifying companies in an early adoption stage of agile practices to allow for deep insights into the challenges and implications of adopting agile practices at enterprises. An overview of the case study companies and conducted interviews is presented in Table 4.

Industry and code name of case study company	Head-quarter location	Comp. size [empl. '000]	Comp. age [years]	Inter-views [#]	Position of interview candidates
Car manufacturer: IT department ("CarCo")	Germany	100+	100+	7	Project manager agile transformation; team lead DevOps; DevOps sourcing; DevOps consultant
Chemicals company ("ChemCo")	Germany	100+	100+	5	CIO; Head of agile transformation and team members

Global bank ("FinCo")	UK	300+	100+	2	Transformation manager; DevOps consultant
Global energy company ("EnergyCo")	Germany	40	100+	2	Agile transformation manager; DevOps consultant
Global IT-Technology company ("TechCo")	Japan	150+	80+	3	CIO; Agile project manager; Agile team member & senior IT architect
Global tools manufacturing company "ToolsCo")	Liechten-stein	25	70+	2	Regional IT Manager Asia
Insurance company ("InsureCo")	Switzer-land	4	100+	3	Lead agile transformation; Head of IT Strategy; Head of corporate development
Online e-commerce company ("RetailCo")	Germany	50	50+	4	CIO; Head of agile transformation; Project team member; Culture change manager
Services company ("ServicesCo")	USA	16	90+	2	Transformation manager; DevOps consultant
Telecommunications company ("TelCo")	Switzer-land	17	20+	4	Process Innovation & Digitation; Head of Architecture Mgmt.; Prod. Manager and tribe chief S2O

Table 4. Overview and specifics of case study companies and conducted interviews.

Case study insights have been derived in personal interviews in a larger research endeavor on enterprise agility. While aspects related to agile organizations have been covered in a different study, we focus here on the implications of adopting agile practices on the four dimensions of the socio-technical systems theory, actors, structures, tasks, and technology. Consequently, we address in this study in the dimension structure only questions related to governance and not to organization.

A case study design is recommended in exploratory research to allow comprehensive discussions (Langley & Abdallah, 2011). In each company, a minimum of one senior manager (e.g. department/unit head) and at least one employee from the operative level has been identified to gain a diverse view on the implications of adopting agile practices. Additionally, executives and consultants facilitating agile transformation have been interviewed to further triangulate our findings. In total 34 interviews have been conducted between November 2016 and February 2018 in either English or German. Questions were mainly open-end to allow the interviewee the possibility to explore their

experience and views in detail (Yin, 2009). Follow-up questions have been formulated for further clarification purposes. Each interview had a duration of 60-120 minutes and was carried out primarily personally in face-to-face meetings. If further details on the cases were needed, additional interviews have been conducted by telephone/Skype to achieve saturation. The interview results have been documented in detail in form of interview notes and, if permitted, in form of recorded interviews. Subsequently, these interviews have been coded, and reviewed for consistency and completeness by another researcher that has not participated at the interviews.

II.4 Results

II.4.1 Implications of Adopting Agile Practices at Enterprises

Figure 13 provides an overview of the identified areas impacted by adopting agile practices at enterprises and matched with STS theory categories. Topics shaded in dark grey could be identified at more than five cases. Topics shaded in light grey could be identified at 3-4 cases while topics identified at 1-2 cases are shown without shading. For reasons of focus we limit ourselves to topics identified at three or more cases.

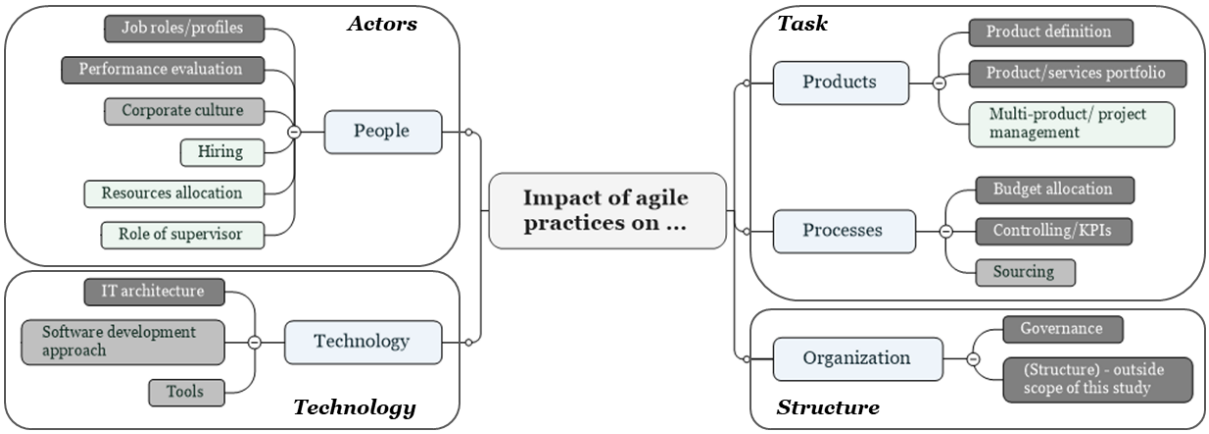

Figure 13. Overview of areas impacted by introducing agile practices at enterprises.

Impact of Agile Practices on Products (STS theory dimension "task")

Products play a key role at agile practices as teams are usually organized according to product features, a product itself, or a product area consisting of several products. While projects are input-oriented, products focus on outcomes and business capabilities and are directly associated to business value (Kim et al., 2016).

Regarding products, our multiple-case study revealed two key aspects affected by adopting agile practices:

(1) Product definition (ChemCo, CarCo, FinCo, InsureCo, RetailCo, ServicesCo, TelCo): This aspect addresses the question of how to design products in an agile setting: Agile practices focus on business capabilities and ensure an end-to-end responsibility for business outcomes. As a result, attention shifts from projects and input-orientation to products and outcome-orientation. While companies traditionally focus on activities and inputs with funding based on projects, agile practices increase the importance of products and outcomes that are centered around long-term business capabilities.

A product can be either a product or service offered to clients or an internal product or service. Most case study companies struggled with the question on how to define products. While product definition is more straightforward in IT where products follow technologies or applications, product definition becomes more challenging when business units adopt agile practices. We observed that an unfortunate product definition increases organizational complexity or interfaces with other units at CarCo and ChemCo since not all required resources were allocated to related products. We observed at RetailCo that some of these situations resolve themselves as monolithic products break up over time into combinable business microservices.

Examples for how to shape products are closely related to the organizational set-up. Observed dimensions included business processes (ChemCo, InsureCo, TelCo), systems or services behind business processes (FinCo, RetailCo), technology/shared services offering (partly FinCo, ChemCo, and CarCo), or combinations of all three dimensions (CarCo, FinCo). As an example, CarCo introduced agile practices in its car engineering department for autonomous driving where products were defined around business capabilities following the autonomous driving value chain. A successful product definition is meaningful regarding services offered to customers and can be clearly separated from other products, e.g. by technology, platform, or different capabilities allowing for a clear resources' allocation.

(2) Product portfolio (CarCo, InsureCo, RetailCo, ServicesCo, TechCo, ToolsCo): This aspect is related to the impact of agile practices on the product portfolio. Agile practices shift attention towards business value and customer journeys. Product portfolios tune themselves fluidly to adapt and cater to customer journeys with the result that a product could cater to more than one journey. This gives rise to a new responsibility for end-to-end quality of service assurance for critical customer journeys which usually happens at the level of the portfolio. As the delivery mode shifts to a product focus, common components can be captured in a delivery platform. The more verticalized products are, the more horizontal a delivery platform will need to be. The more emerging technologies

like API mediation or cloud brokerage are used by the delivery platform, the more "components as a service" can be offered. We observed the following examples for "components as a service" at FinCo, RetailCo, and ServicesCo: Security as a service, identity and access management as a service, platform as a service, and database as a service.

II.4.2 Impact of Agile Practices on Processes (STS theory dimension "task")

As enterprises differ from startups or small companies by well-designed, established and optimized processes, the implications of agile practices on processes need to be considered. We identified three key aspects affected when enterprises adopt agile practices:

(1) Sourcing (CarCo, ChemCo, FinCo, ServicesCo): Adopting agile practices significantly impacts almost the entire sourcing value chain and supplier strategy as vendors become strategic partners managing products over their complete lifecycle. Agile sourcing changes the customer-supplier relationship since it allows for outcome-based partnerships and new ways to collaborate in strategic partnerships. Consequently, adopting agile practices shifts attention from purchasing and contracting to managing of a network of strategic suppliers. We observed a shift from the "right to own an asset" to the "right to use an asset" especially at CarCo which heavily relied on strategic partnerships for building up the autonomous driving ecosystem. Partners worked on new, innovative ways to make resources available with ripple effects on balance sheet related topics like drop in upfront payments and introduction of recurring payments. Novel approaches such as open-sourcing and crowdsourcing are emerging within the software engineering domain, which have consequences for aspects such as innovation and time-to-market (Ågerfalk, Fitzgerald, & Stol, 2015). CarCo and ChemCo excelled at completely redesigning the sourcing process moving to contracting value stories. Comprehensive requirements descriptions and long lists of contracted Service Level Agreements have been replaced by just one KPI – the duration where the user could not work productively with the system.

(2) Budgeting (CarCo, ChemCo, EnergyCo, InsureCo, ServicesCo): Agile practices focus on early time to market and optimize products in iterations based on timely customer feedback. Consequently, planning takes place only short-term for sprint cycles. This heavily interferes with long-term budget planning –exercised at most of the case study companies – as this approach contradicts with short-term sprint planning and allocation of story points for rough effort estimation. We observed that most case study

companies have already adopted a product-oriented budget allocation. EnergyCo for example further developed this approach by establishing a so called "investment board" acting like an internal venture capitalist approving budgets only for sprint cycles based on progress with product features. At CarCo, this venture-capitalist-like budget allocation approach was at the time of research in discussion to be introduced for the development of a new customer-ecosystem.

(3) Controlling (CarCo, ChemCo, FinCo, RetailCo, ServicesCo): Agile practices rely on self-organization of teams and individuals. Consequently, the question of how to control and measure success of agile teams arises. ServicesCo and FinCo completely redesigned metrics to define product success. Designed key metrics include the percentage of builds automated and time to deploy, the number of automated test cycles per day, the percentage of automated testing, the percentage of reduced baseline defects, the number of releases per quarter and the number of days from idea to production. Furthermore, quality of service is no longer measured in incidents resolved, but rather in mean time to recover or mean time between failures.

II.4.3 Impact of Agile Practices on Governance (STS theory dimension "structure")

We observed the impact of agile practices on governance widely. Addressed aspects were twofold:

(1) Coexistence of agile and non-agile units (CarCo, ChemCo, FinCo, InsureCo, RetailCo, ServicesCo, ToolsCo): At enterprises, agile units usually coexist with non-agile like business units. Agile units in need of cooperation with non-agile units are predestined for conflicts due to different objectives, steering, and incentives. ChemCo, InsureCo, ServicesCo, RetailCo, and TechCo addressed this topic by allocating resources with required skills in the product teams to reduce interfaces with other, usually non-agile units. ChemCo installed a dedicated resource for handling interfaces with other departments.

(2) Resolving resources conflicts between products (CarCo, ChemCo, FinCo, RetailCo, ServicesCo): As products should be staffed with resources to manage the product completely, the question arises on how to provide access to specialists required only occasionally. These specialists usually cannot be fully utilized by just one product. Furthermore, a lack of e.g. cyber-security specialists prevents to fully dedicate specialists to just one product. While ChemCo preferred to allocate specialists to related products, FinCo and ServicesCo established cross-product "shared service pods" around

special expertise matters. These shared services pods provide access to expert knowledge on a need's basis for several products. In case of conflicting priorities, we saw decision making either based on topics criticality or first-come-first serve.

II.4.4 Impact of Agile Practices on Information Technology (STS theory dimension "technology")

Having its roots in software engineering to provide ways for software development (Fowler & Highsmith, 2001), agile practices, particularly, affect IT processes, architecture, and tools. We perceived three aspects in our multiple-case study where we observed an impact of agile practices on information technology.

(1) Software development (CarCo, ChemCo, FinCo, InsureCo, RetailCo, ServicesCo, TelCo): Mentioned aspects were threefold: First, product-orientation focuses on early provision of features with highest business value. To achieve this, software development takes places in short iterations aiming at product improvements based on customer feedback. Second, the initial requirements definition phase is shortened significantly as requirements are defined "on the fly" based on learnings and customer feedback. Third, IT-delivery takes place at multiple speeds as required by the business. It is a common misconception that speed in agility is an end in itself: As we learned from FinCo, RetailCo, and ServicesCo, adopting agile practices does not necessarily imply that delivery always must be as fast as possible. Exemplary for early provision of features with highest business value, TelCo designed a process for rapid product development and delivery to customers where features are composed based on standard service components and are put together on lot-size one according to customer specifications. This approach avoids comprehensive requirements and product design phases detached from the customer. Exemplarily, CarCo prioritized its applications portfolio for delivery at multiple speeds according to business priorities and IT delivers at just the minimum speed required by the business. This approach ensures efficient resources allocation and avoids wasting resources for applications or features not valued accordingly by the business.

The question of how to develop according to the "waterfall" in an agile context is closely related to software development. We observed discussions at ChemCo and CarCo related to the question of whether IT should follow a fully agile approach. Especially ChemCo was convinced that even in a fully agile setting development according to "waterfall" would sometimes be beneficial. This is the case when the scope is clear – e.g. pre-defined by tax, legal or regulatory bodies and a predefined feature set needs to

be delivered. For instance, this is the case with an ERP core or for systems managing a shop floor or supply chain. ChemCo addressed this question by defining a template for an agile, non-Scrum, waterfall team which can be flexibly integrated into a fully agile setting. ChemCo currently uses this approach in their biggest IT project ever, the migration from SAP R/3 to SAP S/4 HANA where predominately "waterfall teams" focus on the SAP S/4 HANA core while agile teams develop services around the ERP core.

(2) IT-Architecture (CarCo, ChemCo, FinCo, InsureCo, RetailCo, ServicesCo): Companies excelling at delivery of "right-speed" spend significant efforts on the classification of the applications like ChemCo, CarCo, FinCo and ServicesCo. These companies applied a "pace-layering approach" (Gaughan, Genovese, Shepherd, & Sribar, 2010; Rayner & Van Decker, 2011) where applications are clustered according to strategic priorities: (1) Applications for innovation and new products, (2) business differentiating applications to exploit existing products, and (3) business sustaining applications that are subject to retire. Pace-layering of applications allows to assign different priorities to applications and to redirect resources according to business priorities.

(3) Software tools (CarCo, FinCo, ServicesCo): This aspect addresses implications of agile practices related to software development. Though initially not in focus of our interviews, this aspect was mentioned in interviews at CarCo, FinCo, and ServicesCo. Interviewees stressed the importance of standardized tools for agile software development. Exemplary products mentioned by more than one company were Jira for product definition, Eclipse for coding, GitLab for source control, Jenkins for build, Parasoft for testing and Ansible for deployment. As CarCo is establishing a system for autonomous driving in strategic partnerships with other car manufacturers and suppliers, an early alignment across all partners on which specific tools to use has been mentioned as critical.

II.4.5 Impact of Agile Practices on People (STS theory dimension "actors")

According to the Agile Manifesto, individuals and interactions should be valued over processes and tools (Fowler & Highsmith, 2001). Consequently, people play a crucial role when agile practices are adopted.

(1) Job-profiles and roles (ChemCo, InsureCo, ServicesCo, TelCo, ToolsCo): The adoption of agile practices impacts roles and job profiles: In a fully agile setting, there is no disciplinary supervisor as it is still the case at most enterprises. Rather, the

employee needs to take on own initiative and actively contribute to self-organization of the product team. Taking on initiative is neither easy nor necessarily desired by all team members: As observed at ToolsCo, the offshore unit, which develops mobile apps and is in Malaysia, had applied Scrum and reorganized according to a fully agile setting. Product owners reported that some team members were lacking the initiative to engage in sprint planning and estimating feature development effort with story points and, surprisingly, claimed to rather focus on coding instead.

Consequently, adopting agile practices impacts job profiles as not only different skills are required but also new jobs are created. We observed the following new positions being created at ChemCo, InsureC0, and ServicesCo: Data scientist, team builder and coach, business process analyst, UX/UI designer, technical broker and a product owner in the role of "broker and communicator" between business and IT.

(2) Performance appraisal and compensation mechanisms (CarCo, ChemCo, FinCo, InsureCo, ServicesCo, TelCo, ToolsCo): A second impact of agile practices on people addresses the question of how to conduct performance assessments and to decide about promotions, bonuses or salary increases: In a non-agile setting, supervisors are taking care. Contrary, a fully agile setting relies on self-organized teams where the product owner takes on responsibility exclusively for business outcomes of the related product.

We observed intensive discussions regarding performance assessments at InsureCo, TelCo and ServicesCo. Team members were assigned full freedom to organize their work independently and to get rid of management by objectives or performance appraisals. This confirms the findings of a study describing the systematic side effects of "overprescribing goal setting" (Ordóñez, Schweitzer, Galinsky, & Bazerman, 2009). InsureCo and ServicesCo started to introduce a team-based performance appraisal mechanism where team members assess each other 360 degrees regarding performance and perceived business value contribution of each team member.

(3) Corporate culture (InsureCo, RetailCo, ServicesCo, TelCo, ToolsCo): The question of how agile practices influence culture was intensively discussed at InsureCo, RetailCo, and TelCo. The inherent corporate culture has been mentioned as critical for a successful adoption of agile practices. Numerous studies confirm this finding by identifying culture as the most critical hurdle for agile transformation (Buvat et al., 2017). InsureCo, an industry leader regarding adoption of agile practices, revealed that change management related to corporate culture is key priority for 2018. Consequently, changing corporate

culture according to agile practices is at InsureCo not driven by the IT department or agile teams but governed by the CEO to emphasize commitment and importance.

II.5 Discussion and Conclusion

As agility changes everything (Kulak & Li, 2017), we have observed far reaching challenges and implications when enterprises adopt agile practices. While first steps towards agility are often made quickly, the challenge starts when agile units need to collaborate with non-agile units. When "agile meets non-agile", self-sufficient teams are exposed to non-agile processes finetuned for efficiency, reliability, and security. The question on how to balance between "keeping the lights on" with existing non-agile units and concurrently engaging in exploration and innovation (Dixon, Brohman, & Chan, 2017) is currently omnipresent.

Agility as a phenomenon has already been addressed extensively (Conboy, 2009). While previous research primarily focused on agility as software development method (B. Fitzgerald & Stol, 2017; Fowler & Highsmith, 2001), as form to organize startups or strategically insignificant units dealing with innovation (Scott W. Ambler, 2001), our research is motivated by the lack of empirical evidence on the implications of adopting agile practices at enterprises. Accordingly, an exploratory study with ten cases has been conducted to get a deeper understanding of the specifics of enterprise agility and the resulting implications of adopting it.

Derived insights are threefold: First, well-established, traditional businesses are currently adopting agile practices at large scale. Second, contrary to startups or digital-native companies, enterprises are exposed to specific challenges preventing a seamless adoption of agile practices (Highsmith, 2013; Kim et al., 2016). Frequently observed barriers are the existence of huge amounts of historic data, well-established and highly optimized processes, and a high amount of historically grown and company-specific legacy systems. Third, the adoption of agile practices impacts not only the affected agile unit itself, but also almost the entire company. By applying STS theory, we found that all four dimensions of a works system (i.e., actors, structures, tasks and technologies) are impacted when agile practices are adopted by enterprises.

To our best knowledge, this is one of the very first exploratory multiple-case studies dealing with the implications of adopting agile practices at enterprises. Our study has several practical contributions: Well-established, existing companies get a better understanding of the specific challenges they are confronted with when adopting agile practices. Furthermore, our multiple-case study reveals insights into areas affected by

agility and exemplary shows how leading, global companies address some of these challenges.

This study does not come without its limitations: We have identified ten cases to be as representative as possible for enterprises turning into agility. Selected case study companies might not be fully representative for all industries. Furthermore, except for FinCo and InsureCo, most case study companies are at an early innovation assimilation stage. Consequently, companies at later adoption stages might be faced with different challenges by adopting agile practices and come up with different solutions.

Accordingly, future work should stress importance on the following aspects: First, to understand more about the challenges of adopting agile practices at different maturity stages of the agile transformation. Because most enterprises started their agile transformation just recently, accessible cases in a more mature adoption stage are limited. Second, we perceive a significant research gap related to what differs startup agility from enterprise agility and to the related hurdles for enterprises to adopt agile practices. Third, insights into how enterprises mastered the challenge when agile units need to collaborate with non-agile units in a longitudinal perspective might provide important insights for practitioners.

Despite of disruptive challenges resulting when enterprises adopt agile practices, the journey to enterprise agility seems to be more than a one-time, transitory trend and will be a cornerstone to increase speed and flexibility. Successfully mastering the challenges resulting from the adoption of agile practices will be crucial for a sustainable and successful journey to enterprise agility.

III: Agile Contracts: Learnings from an Autonomous Driving Project

Title	Agile Contracts: Learnings from an Autonomous Driving Project
Authors	Gerster, D., Dremel, C.
Outlet	Proceedings of the 27th European Conference on Information Systems (ECIS), Stockholm, Sweden
Year	2019
Status	Published

Figure 14. Bibliographic Information for Article III

Abstract. New digital services and products rely heavily on digital technologies and need to be deployed in an ever-shorter timeframe in response to rapidly changing market demands. To address this challenge, more and more companies are applying agile practices to increase speed and flexibility. In consequence, companies review their sourcing strategies to shorten the duration of tenders for large-scale IT projects and to increase flexibility in contracting of IT services to cope with the anticipated consequences of digital transformation. This study aims at revealing how agile practices could help to re-duce time-to-market and to increase contract flexibility. As the automotive industry is especially affect-ed by the adoption of new digital technologies, this revelatory case study shows how a German car manufacturer increased agility in sourcing and contracting of an autonomous driving development platform. Agile practices turned out to be essential in dealing with technological novelty and hurdles, regulatory uncertainty, and frequently changing requirements. We contribute to the extant knowledge by providing practical recommendations on how to increase agility in sourcing and contracting of large-scale IT projects.

Keywords: IT sourcing, agile sourcing, agile contracts, autonomous driving

III.1 Introduction

New digital services and products rely heavily on digital technologies (Ross et al., 2016; Weill & Woerner, 2015) and need to be deployed in an ever-shorter timeframe in response to rapidly changing market environments (D'Aveni et al., 2010; Overby et al., 2006). In consequence, more and more companies adopt agile practices to increase speed and flexibility (Gerster, Dremel, & Kelker, 2019; Highsmith, 2013). The adoption of agile practices has widespread implications on products, processes, technology, people, and structure that are just beginning to be understood (Gerster et al., 2018). The sourcing and contracting of IT services is especially affected by the need to increase speed and flexibility as frequently changing requirements are in conflict with strict and long-lasting contracts (Arbogast, Larman, & Vodde, 2012). In consequence, companies review their sourcing strategies to reflect agile delivery, reduce tender duration and to increase contract flexibility (Demirbas, Gewald, & Moos, 2018; Gewald & Schäfer, 2017).

Against this backdrop, this study takes the sourcing and contracting of IT services as an example for a domain being especially affected by digital transformation. Extant research on sourcing and contracting of IT services deals primarily with large IT projects in a non-agile context (Gewald & Schäfer, 2017), focuses on aspects of IT delivery or governance related to IT outsourcing (Dibbern, Goles, Hirschheim, & Jayatilaka, 2004; Lacity, Khan, & Willcocks, 2009), aims at reducing contractual risks but does not look at project success or missed business opportunities (Arbogast et al., 2012), looks at specific aspects of agile contracting, or lacks practical advice on how the overall tender duration can be reduced (Pries-Heje & Pries-Heje, 2014).

This study is motivated by the lack of knowledge and practical advice on how to increase agility in the sourcing and contracting of IT services in the context of large-scale IT projects and aims at addressing the research gap related to the need to extend the applicability of agile practices beyond software development (Conboy, 2009). In particular, we aim at generating insights into how agility could be increased in sourcing and contracting of large-scale IT projects – in our case an IT platform for the development of autonomous driving capabilities – with the following research question: *How can agility be increased in sourcing and contracting of large-scale IT projects?*

To do so, we target the automotive industry as it is highly affected by technological innovations such as business analytics, electromobility or autonomous driving (Deloitte, 2015; Dremel et al., 2018; Mocker & Fonstad, 2017). Our case study setting with a German car manufacturer (OEM) includes technological novelty (i.e. autonomous

driving and machine learning) and technical hurdles (i.e. analyzing data volumes of up to 200 Petabyte) with frequently changing functional requirements or unclear regulatory requirements in combination with an ambitious timeline (i.e. begin of series production planned for 2021). With our exploratory research endeavor we aim at illuminating the far-reaching implications of adopting new digital technologies in context of an organization applying scaled agile practices and structures according to the framework LeSS (Larman & Vodde, 2017).

III.2 Theoretical Background

This section introduces relevant extant literature. We address the disconnect between agile information systems development (ISD) and vendor management and examine how agile practices address issues of traditional software development and how they impact contracts and could reduce related risks.

III.2.1 The disconnect between agile ISD and vendor management

Agile practices can be seen as a response to challenges resulting from the traditional way of software development according to "Plan-Build-Run" (Royce, 1987) and the resulting separation between build and run (Rigby et al., 2016). Agile practices root in systems thinking and lean practices (Conboy, 2009; B. Fitzgerald & Stol, 2017). The Agile Manifesto is perceived as a practitioners' collection of best practices on agile ISD (Fowler & Highsmith, 2001). Agile practices can be exemplarily characterized as follows: Formulation of value stories, removing complexity, shortening release cycles to incorporate customer feedback, and the estimation with story points to reduce effort estimation complexity (Conboy, 2009; Rigby et al., 2016; X. Wang et al., 2012). Agile practices aim, for instance, at clean code, pair programming and immediate customer feedback, test-driven development, automated testing, continuous deployment (B. Fitzgerald & Stol, 2017) and achieve their benefits through the synergistic combination of individual agile practices (B. Fitzgerald, Hartnett, & Conboy, 2006).

For reasons of focus we do not include details on the composition of agile teams or their daily practices in this study but refer to the wide body of extant knowledge: Good references on the essentials of agile teams and their structures are Kniberg (2012) and Gonçalves and Lopes (2014) expalining the setup of agile teams with the case of Spotify. Recker (2017), Przybilla (2018) or Wang (2012) present various insights into the applied daily practices of agile teams like stand-ups, planning poker to estimate development efforts with function points or retrospectives. Related to project management practices,

McAvoy and Butler (2009) highlight the changing role of the project manager in agile ISD as a devil's advocate where teams are empowered to decision making.

The rich literature on IT sourcing is closely related to IT outsourcing which can be defined as "handing over the management of a function, assets, people, or activity to a third party for a specified cost, time and level of service" (L Willcocks, Oshri, & Rottman, 2015, p. 3). In consequence, IT outsourcing can be regarded as a specific form of IT sourcing. Topics of managing risks in IT contracts or governance and vendor management take a prominent take in the extant IT outsourcing literature (Lacity et al., 2009; Liang, Wang, Xue, & Cui, 2016). Consequently, questions of how to reduce risks and uncertainty in the relationship between the client and the provider e.g. by a tight management with service level agreements (SLAs) or a strict provider governance play an important role from an IT outsourcing perspective (Wu, Straub, & Liang, 2015).

While IT outsourcing was in the past largely motivated by optimization and cost efficiency (Lacity et al., 2009), its focus has shifted towards innovation while offshoring activities have declined in importance (Gewald & Schäfer, 2017). The digitalization of business processes, cloud computing and cyber-security will have a similar disruptive potential in the upcoming years (Demirbas et al., 2018; IDG, 2017). Consequently, companies are motivated to review their sourcing strategies to reflect the anticipated implications of digital transformation and to increase agility in IT sourcing (Demirbas et al., 2018).

III.2.2 Incomplete contracts

Incomplete contracts are argued to explain various economic issues (Tirole, 1999). Incomplete contracts are usually preceded by an invocation of transaction costs and one or several of the following three ingredients: Unforeseen contingencies, cost of writing contracts, or cost of enforcing contracts (Tirole, 1999). Key ideas of the incomplete contracts literature are that contracts are incomplete by nature (Hart & Moore, 1988, 1999) and result from information asymmetries between seller and buyer and, thus, explain for a suboptimal level of sourcing (Tirole 1999).

Since it is not feasible to include all contingencies into contracts, information asymmetries between buyer and seller result (Hart & Moore, 1988). Consequently, contracts need to find a way to handle uncertainty by assuring cost-efficiency and contract reliability. Agile contracts are perceived as one way to address contract uncertainties and to increase manageability (Arbogast et al., 2012; Opelt, Gloger, Pfarl, & Mittermayr, 2013).

III.2.3 How agile practices address issues of traditional ISD

Key issues inherent to traditional ISD are that developing complete functional specifications is usually (1) not economical since it requires considerable effort before implementation starts (Book, Gruhn, & Striemer, 2012); (2) not feasible since learnings of first iterations of feature development cannot be incorporated (Kim et al., 2016); and (3) not helpful since the client usually remains unable to express all requirements in sufficient complete and consistent detail up front (Kulak & Li, 2017). As a result, in situations of frequent changes or unclear requirements endless re-negotiation of requirements may result when traditional approaches to ISD are applied (Pries-Heje & Pries-Heje, 2014).

Contrary, agile practices can help to address some key issues of traditional ISD: (1) Simple design: The recognized lack of helpfulness of complete up-front specification of functional requirements has led to the rise of agile software development methods such as Scrum (Schwaber & Beedle, 2002) where voluminous specifications are replaced by lean specifications (Book et al., 2012). (2) Sprint planning focusing on business priorities: Sprints are planned according to business priorities as specified by the product owner as a representative for the client's priorities (X. Wang et al., 2012). (3) Small releases are deployed in short, iterative sprint cycles: By this approach, simple functionality is deployed quickly in sprint cycles of two to three weeks (Hekkala et al., 2017; X. Wang et al., 2012). Short sprint cycles ensure that new features can be deployed early, shipped iteratively, piece by piece (Austin & Devin, 2009). Furthermore, changing requirements can be taken into account within a reasonably short timeframe (Ågerfalk, Fitzgerald, & Slaughter, 2009). (4) Continuous testing and integration: New functionality will be tested and deployed instantaneously without waiting for big release bundles (B. Fitzgerald & Stol, 2017). (5) Pair programming: Pair programming ensures a quality check already during coding as one developer codes and another checks quality (B. Fitzgerald & Stol, 2017). (6) Self-organizing teams: Distributed leadership and decision making speed up decision making and ensure that required information is readily available (Hekkala et al., 2017). (7) Additional agile management practices: Daily stand-ups and retrospectives serve as supporting organizational culture as they facilitate team communication on sprint status and foster learning and continuous improvement (Hekkala et al., 2017; Recker, Holten, Hummel, & Rosenkranz, 2017).

Applying these agile practices to ISD has three implications: First, time-to-market for critical features can be reduced as features with high business impact can be prioritized by the product owner (Ågerfalk et al., 2009). Second, product quality can be increased

due to early and automated testing, incorporated quality checks due to pair programming, communication and mutual feedback (B. Fitzgerald & Stol, 2017). Third, flexibility for deployment of changing features can be increased due to short, iterative sprint cycles and lean requirements specification (Coram & Bohner, 2005).

An agile and iterative approach to ISD can therefore – by design – decrease risk and uncertainty and can protect clients from things they may not know (Arbogast et al., 2012). Furthermore, an agile approach limits both the scope of the deliverable and extent of the payment and allows for inevitable change, and focuses negotiations on the neglected area of delivery (Arbogast et al., 2012).

III.2.4 The impact of agile practices on contracts and related risks

Incorporating agile practices into IT contracts significantly impacts both, fixed price and time and material (T&M) contracts as large and precisely specified contract volumes will be replaced by modules sourced in small and iterative packages (Opelt et al., 2013). Consequently, specific challenges occur for both, fixed price and T&M contracts: Related to fixed-price contracts, challenges exist regarding contract negotiation caused by lean requirements specifications: The overall project scope is defined only high level causing difficulties in finding an agreement of whether the requirements are fulfilled or not (Opelt et al., 2013). Furthermore, project scope and solutions materialize only gradually and prototyping implies performing a considerable amount of work that does not make it into the final project (Book et al., 2012) making it difficult to reach a fixed-price agreement in an agile setting (Opelt et al., 2013).

Similarly, T&M contracts face challenges regarding agile practices reflected in contracts as well: While T&M contracts seem fairer at first sight as the payment corresponds exactly to the delivered work, they incentivize the provider to increase the development effort and neglect quality control (Book et al., 2012). As a result, implementation risks are fully with the client (Pries-Heje & Pries-Heje, 2014).

To summarize, closing contracts is a challenging undertaking especially in the context of technological novelty and uncertainty like software development (Opelt et al., 2013). Most importantly, successful contracts result from relationships that rely on trust, collaboration, and transparency (Arbogast et al., 2012). Agile contracts acknowledge the fact that all contracts are incomplete, thus setting up mutually agreed-upon frameworks that explicitly address the management of contingencies (Arbogast et al., 2012).

III.3 Research Approach and Case Study Context

III.3.1 Research approach

This study applies an inductive qualitative research approach due to the novelty of the need to increase agility in IT sourcing and contracting exemplarily shown in the context of autonomous driving. Therefore, we conduct a revelatory single case study (Yin, 2009) because of the lack of related extant knowledge and to get rich, in-depth empirical insights. This case study is revelatory for two reasons: First, this case study provides access a phenomenon of interest that has been largely inaccessible to previous research due to topic novelty (i.e. sourcing of a technological innovation facing unclear or frequently changing requirements). Second, researchers have usually limited exposure to companies applying agile practices to IT sourcing and contracting as this is a rather new and rare instance. In consequence, we opt for a revelatory case study design to maximize the chances of credible novelty (Langley & Abdallah, 2011).

To obtain in-depth qualitative data, exploratory interviews with managers, experts, and sourcing advisors involved in the project were conducted as primary source for data collection. Initial interviews were conducted between September and November 2018 in either English or German based on a semi-structured interview guideline following the recommendations of Schultze and Avital (2011) and Strauss and Corbin (1990) to ground the interviews in the participants' own experiences and to allow the theory to emerge from data. The remaining interviews will be conducted in spring 2019.

Questions were formulated mainly open-end to allow the interviewees the possibility to explore their experience and views in detail (Strauss & Corbin, 1990; Yin, 2009). Follow-up questions were formulated for further clarification purposes. Each interview had a duration of approximately 50-75 minutes and was carried out personally in face-to-face meetings. The interview results were documented in detail in form of interview notes and, if permitted, in form of recorded interviews. The interviews were coded and reviewed for consistency and completeness by another researcher that has not participated at the interviews. Table 5 provides an overview of the already conducted and planned case interviews.

Organization/ department	Interviewees	Status
Car development (business unit)	Executive sponsor/ Manager; Team leads; Experts	3 conducted; 5 in planning
Corporate IT (IT department)	Manager; Experts	1 conducted; 3 in planning

Purchasing (incl. legal and cost engineering)	Team lead; Sourcing and cost experts; Sourcing legal advisor	In planning (3 interviews)
Consulting (external sourcing advisors)	Consultants, Project Manager	2 conducted; 3 in planning

Table 5. Overview of conducted and planned case study interviews.

III.3.2 Case study context: Current state and sourcing challenges

This case study takes the sourcing and contracting of an autonomous driving development platform at a leading OEM as an example to examine the implications of applying agile practices to IT sourcing and contracting. The OEM seeks to develop own autonomous driving capabilities related to high and full autonomous driving (level 4 and 5) according to SAE's definition (Herrmann, Brenner, & Stadler, 2018; SAE, 2018) with intended deployment in serial production in 2021. The development platform will be used for programming, simulating and testing of the autonomous driving code to be deployed in cars.

Contrary to traditional large-scale IT projects, three aspects of this case study are especially noteworthy: First, despite of its strong technology focus, the lead for specification, selection, and implementation of the autonomous driving development platform is with OEM's car development unit. Consequently, resources from corporate IT contributed with subject-matter expertise in an advisory role only. Second, the corresponding business unit for car development consists currently of approx. 900 employees and is organized according to the scaled agile framework LeSS (Larman & Vodde, 2017). Third, the OEM engages for the development of autonomous driving capabilities in partnerships with other car manufacturers and original equipment suppliers (OES) with split responsibilities for features. This setting creates specific challenges as technical compatibility needs to be ensured between cooperation partners.

In consequence, the following challenges resulted highlighting the necessity to deviate from traditional approaches to IT sourcing and contracting: (1) An ambitious timeline as the autonomous driving development platform needs to be available in spring 2019 to secure start of serial production in 2021; (2) technological novelty as neither the OEM, nor providers had previous experience in establishing an autonomous driving development platform of this scale and scope; (3) technical hurdles due to exceptionally high data volumes caused by high and full autonomous driving, i.e. 200 PB of data storage; (4) unclear or not fully specified legal framework for operations of autonomous driving systems in the intended markets – Europe, Japan, and the US; (5) unclear or

frequently changing requirements due to the novelty of autonomous driving; (6) multi-partner setting with other car manufacturers and OES involved; (7) resulting contractual challenges like a not fully specified scope, unclear quantities as for instance the maximum number of users cannot be predicted due to the multi-partnering approach.

III.4 Preliminary Results

Preliminary results are derived from initially conducted interviews and are related to increasing agility during the tender and in the resulting contract. In line with Kulak and Li (2017) and Opelt et al. (2013), we observed that agility could play an important role in reducing overall tender duration and contractual uncertainty. The latter is especially important when digital technologies involve technological novelty.

Increasing agility in IT sourcing mainly targets at reducing overall tender duration. A backwards calculation revealed that the autonomous driving development platform would need to be up running in March 2019 to ensure start of serial production in 2021. To achieve this ambitious goal, contract signature had to take place in November 2018. Consequently, a time frame of roughly nine months for defining the tender scope including volumes, services, functionality, technical concepts and for vendor selection including contract negotiation resulted. The high-level tender timeline is displayed in Figure 15.

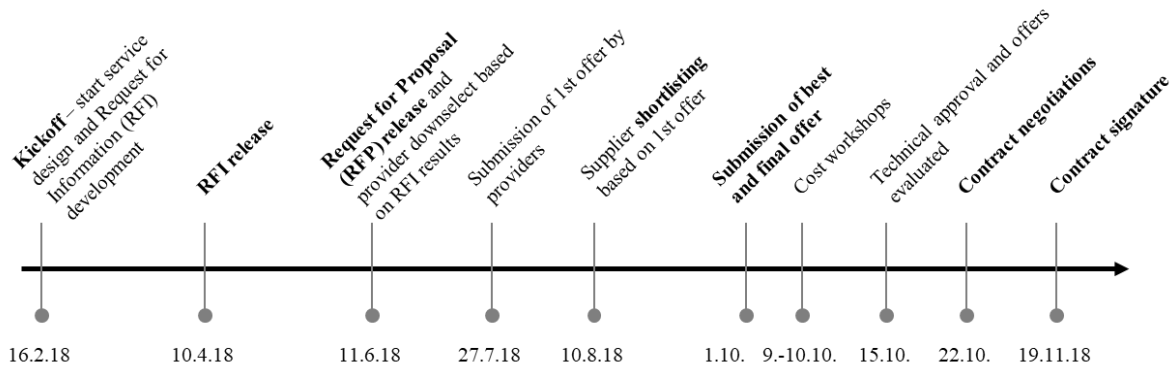

Figure 15. Timeline for the tender of the autonomous driving development platform.

The following measures have been identified to increase agility in sourcing of the autonomous driving development platform aiming at reducing the tender duration:

(1) Focus on business outcomes ("value stories") without specifying the means of realization. To achieve this, desired business functionalities were defined only high-level as desired outcomes, but details of the realization were left completely up to the provider. This approach follows the agile practice of focusing on business outcomes and

to create freedom for the implementation teams to decide about the realization (Fowler & Highsmith, 2001; Kulak & Li, 2017). This approach significantly differs from traditional ISD using comprehensive statements of work often also specifying details and related technologies for realization of the desired functionalities. Examples for business services include the collection of camera, lidar, and sensor data of test drives, the ingestion of collected test data to the centralized platform, or the simulation of the autonomous driving code based on new sensor set-ups. The freedom of providers to decide on details of realization is perceived as lever to shorten tender duration as providers are free to select technologies of their choice (Opelt et al., 2013).

(2) A lean requirements specification describing features only high-level was applied for three reasons: First, to shorten the duration for requirements specification, second, to create freedom for providers on services provisioning, and third to include providers in the solution design at an early stage to leverage their ideas and creativity addressing technical challenges. Only platform key volumes like storage volume or computation time for specific operations were specified. This approach follows the recommendations of the Agile Manifesto that best architectures and requirements designs emerge from self-organizing teams (Fowler & Highsmith, 2001) and reduces overall tender duration (Arbogast et al., 2012).

(3) A service catalogue has been used to describe business services in a structured, standardized and comprehensive way. A service catalogue describes required services in a formal structure and links them with service levels and quantities (Arcilla, Calvo-Manzano, & San Feliu, 2013; Mendes & da Silva, 2010). The service catalogue turned out to be especially beneficial in reducing tender duration: Providers submitted the service catalogue complemented with prices for requested services and quantities along with provider-specific assumptions. Provider-specific assumptions were then reviewed in so called "walk-through-sessions". The documentation of accepted changes in the separate document stating provider-specific assumptions became part of the contract. This process ensures that the original contract text remains unchanged. Contrary, changes in contract texts are usually time-consuming as they need to be aligned and approved by each party. Consequently, the tender duration could be significantly reduced.

(4) As part of the Request for Proposal (RFP), a detailed discussion between the client and potential providers on the intended solution took place in workshops. This procedure ensured that the provider could gain a profound understanding of the requested functionality and gave the client the possibility to get familiar with the technical solution

proposed by the provider and to, thus, reduce inherent uncertainty before contract signature. Consequently, solution design was similar to agile sprints where solution design takes place in iterative cycles immediately incorporating client feedback (Kim et al., 2016).

To conduct a profound vendor selection and to increase confidentiality in the future provider, the following measures were taken: A Request for Information (RFI) has been initially launched to conduct a provider pre-screening and qualification. Despite of consuming almost two months of the available tender duration, the RFI was perceived as very valuable for the following reasons: (a) the ability to address a potentially wider range of providers with the possibility for a vendor pre-qualification; (b) to launch the RFI at an earlier point in time as – contrary to the RFP – not all requirements needed to be defined; (c) to incorporate learnings on smart solutions made during the RFI into the subsequent RFP; and (d) to give providers the possibility to understand the client's requirements and tender scope at an earlier stage.

Contract flexibility was highly important while at the same time a fix-price was intended to achieve cost-reliability. We observed the following two key measures to increase contract flexibility:

(1) Only initial quantities for the first quarter after contract signature were specified: All remaining quantities for the remaining contract duration would be specified during the course by an "investment board", a monthly meeting of client and provider representatives. The investment board is intended to review system utilization in the previous month and would adapt future quantities within a quarter's lead-time. This approach aims at ensuring maximum flexibility regarding ramp-up of computing power or storage, and other systems key parameters. Simultaneously, the provider has enough time to provide requested capacities. To ensure that deployed capacities will not be cancelled by the client before the usual lifetime, the parties agreed that quantity flexibility was limited with respect to two conditions: First, a ramp-down of already deployed capacities would be reimbursed by the client with the anticipated cost for the remaining contract lifetime of the respective component. Second, the ramp-up of capacities would be limited to a maximum of 20% exceeding the already deployed capacity to ensure that the ordered capacity increase can be feasibly deployed without within a quarter's time frame. In case of disputes, an agreed governance with defined escalation mechanisms would apply.

(2) To significantly speed up requirements specification for application development services, only a rough indication of the required skills and related quantities was given during the tender: To secure resources availability, the client committed on quantities for application development according to so-called 'T-Shirt-sizes'. T-Shirt sizes ranked from S to XL describing an average person day effort for feature development ranging from T-shirt size XS (equaling one person day) to XL (equaling 21 person days). Furthermore, the client specified the shoring mix for each ordered T-Shirt size to allow planning of regional availability of application development resources as requested.

Cost-efficiency is intended to be achieved with the following two measures: First, aiming at a fixed price agreement despite of flexible scope in an agile setting: A fixed price has been agreed based on the scope and quantities as specified in the service catalogue. This procedure ensured that the provider had no incentive to increase the scope without receiving additional payment. Second, cost-efficiency has been achieved by focusing SLAs on business process impact, e.g. interruption of business processes and not the availability of single system components. This approach ensured that only SLAs of relevance for business impact were negotiated which in turn facilitated a swift contract negotiation of SLAs.

III.5 Future Research and Conclusion

Companies increasingly adopt agile practices to foster innovation and performance in rapidly changing market environments (Sambamurthy, Bharadwaj, & Grover, 2003). While agile practices are widespread at startups or born digital companies like Amazon or Google (Tumbas et al., 2017a), traditional companies started to adopt agile practices just recently (Gerster et al., 2018).

This study aims at revealing the implications and potential benefits of applying agile practices to the sourcing and contracting of large-scale IT projects. Accordingly, our research is motivated by the lack of empirical evidence on how agility can be increased in the sourcing and contracting of IT services by referring to a revelatory case study with an OEM in the context of autonomous driving. We contribute to the rich body of knowledge on IT sourcing and contracting with examples on how to reduce the duration of large-scale IT tenders and to increase the flexibility at IT contracts. This case study provides insights into how contract uncertainty could be reduced by applying agile practices to contracts.

This study has the following limitations: This case of a leading OEM in the context of autonomous driving might not be transferrable to companies of other industries or size

classes. Specifically, prestige projects involving technological innovation increase the likelihood that a provider engages in new or uncommon contract types. Furthermore, due to topic novelty, only the time frame related to the platform sourcing could have been considered. A longitudinal study of how the agile principles formulated in the contract would come into live after contract start seems to be especially worthwhile.

Our future research will cover the following aspects: First, we intend to conduct the remaining planned interviews as outlined to get a more diverse view on how to increase agility in IT sourcing and contracting. Second, we aim to understand which measures have been taken to shorten the sourcing project's overall tender duration and which implications derived. Third, we intend to examine which measures were designed to increase contract agility. Finally, we intend to conduct a longitudinal observation to examine how the selected agile contract elements work in practice and to which extent contract flexibility could be increased.

Despite of the novelty of the content and the significant challenges imposed by the adoption of agile practices to IT sourcing and contracting, agility seem to be more than a short-term, transitory trend and is likely to play an important role as companies seek to increase speed and flexibility in response to rapidly changing market environments. It remains striking to learn how agility can be increased in sourcing and contracting of large-scale IT projects.

IV: Scaling Agility: How enterprises adopt agile forms of organizational design

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Figure 16. Bibliographic Information for Article IV

Abstract. The question of how to increase speed and flexibility in times of digital disruption is essential to almost any company. While previous research mainly addresses agility in the context of software development, as form for organizing startups or "born digital" companies, little knowledge exists about agility at enterprises. With an exploratory study of ten global cases, this paper aims at examining how enterprises adopt and scale agile forms of organizational design. Our preliminary results reveal that (1) agile forms of organizational design are currently adopted by enterprises at large scale and successively replace bimodal IT structures where agile and non-agile units coexist in parallel, (2) Spotify's organizational design serves as a widely used template for a fully agile unit, and (3) enterprises fine-tune this template to their needs and scale.

Keywords: Agile organization, agile transformation, bimodal IT, enterprise agility

IV.1 Introduction

Digital transformation is ubiquitous and requires companies to "rethink how they interact with customers, define value propositions, leverage data, and organize internal operations" (Joehnk et al., 2017, p. 1). New competitors create new products or services and business model innovation takes place with the help of digital technologies (Weill & Woerner, 2015). Thus, digital transformation imposes the need to continually sense and respond appropriately to frequently changing markets (D'Aveni et al., 2010; Overby et al., 2006). Against this backdrop, the question of how to increase agility plays a crucial role as companies are creating new combinations of digital and physical components for product innovation in response to rapidly changing market environments (Yoo et al., 2010).

Enterprises adopt and scale agile practices to increase speed and flexibility, and, thus to increase agility (Highsmith, 2009). While agile practices are inherently linked to software development and were initially considered to be only suitable for small, and co-located teams (B. Fitzgerald & Stol, 2017), the need to scale agile practices and their corresponding forms of organizational design beyond IT at the entire organization to tackle digital transformation has emerged (Leffingwell, 2007). Enterprises are now on the edge of adopting agile forms of organizational design to increase speed and flexibility (B. Fitzgerald & Stol, 2017). Consequently, organizations are successively moving away from transitional structures like bimodal IT where only parts of the organization are organized according to agile design principles towards structures where the entire organization applies them (Roemer et al., 2017).

Despite the growing agility literature (Conboy, 2009), research on how traditional enterprises adopt and scale agile forms of organizational design to increase agile capabilities calls for a deeper understanding of (1) the application of agile forms of organizational design outside of software development (Kiely et al., 2017), (2) the applicability of agile methods beyond small and co-located development teams (Abrahamsson et al., 2009), (3) how organizations can be structured to maximize benefits of adopting agile forms of organizational design (Maruping et al., 2009), and (4) which agile forms of organizational design exist beyond the initial adoption stage (Abrahamsson et al., 2009).

This study aims at responding to this call for research with the following research question: *How are agile forms of organizational design adopted and scaled at enterprises?*

While the adoption of agile practices or scaled agile frameworks like LeSS or SAFe is out of scope, this study focuses at generating insights on how enterprises adopt and scale agile forms of organizational design by drawing on a multiple-case study with ten cases from global companies across different industries.

IV.2 Theoretical Background

This section briefly introduces the relevant theoretical concepts. We refer to related research on the roots of agile practices and organizational design, concepts in IS research such as bimodal IT and ambidexterity, agility at scale, enterprise agility, and generic concepts of agile forms of organizational design. Finally, we introduce Spotify's organization which serves as a widespread template for a fully agile organization.

IV.2.1 Roots of Agile Practices and Organizational Design: Software Development

Agile practices and forms of organizational design can be seen as a response to challenges stemming from the traditional way IT is organized following "Plan-Build-Run" (Royce, 1987) and the resulting separation between build and run (Fowler & Highsmith, 2001). Agile practices root in systems thinking and lean practices (Kulak & Li, 2017; Larman & Vodde, 2017; Leffingwell, 2007). Systems thinking is about changing our perspective to solve problems in new and unexpected ways (Deming, 2000). The Agile Manifesto is seen as the basis for agile practices and aims at designing "better ways of developing software by doing it and helping others do it" (Fowler & Highsmith, 2001, p. 2).

Agile practices and forms of organizational design are closely related to IT due to their roots in software development (Fowler & Highsmith, 2001). IT agility is characterized by the following practices: Formulation of value stories, removing complexity, shortening release cycles to incorporate customer feedback, and the estimation with story points to reduce effort estimation complexity (Kim et al., 2016). Agile practices aim, for instance, at clean code, pair programming and immediate feedback, test-driven development, continuous integration, and automated testing (Kulak & Li, 2017). Introducing agile practices or forms of organizational design in the IT function alone is not sufficient and requires "a more holistic approach […] than one which is merely focused on continuous integration of software" (B. Fitzgerald & Stol, 2017, p. 176). The benefits of applying agile practices in the IT function alone will be sub-optimal if they are not supplemented by agile forms of organizational design in related organizational functions such as finance, HR, legal, or procurement (Overby et al., 2006).

IV.2.2 Related Concepts in IS Research

The term bimodal IT was initially coined by practitioners and is related to ambidexterity (Joehnk et al., 2017). Ambidexterity is the ability of simultaneously pursuing exploitation and exploration (O'Reilly & Tushman, 2008; Raisch et al., 2009). Exploration is related to innovation capabilities and to "recombine potential resources in novel ways to create new capabilities and opportunities" (Lee et al., 2015, p. 400) whereas exploitation is related to the efficient leverage and refinement of existing resources through known processes (Lee et al., 2015; March, 1991). Against this backdrop, bimodal IT refers to ambidexterity through the ability of managing two separate but coherent working styles: One focusing on exploration, the other on exploitation (Bygstad, 2015). Companies engage in bimodal IT to increase IT agility, IT exploratory capabilities, and the need for a structured business-IT alignment (Haffke et al., 2017b; Horlach et al., 2016).

As organizations scale, so do development and operations units in the IT function. Practitioners made several attempts to scale agile practices to the enterprise level: LeSS (Large Scale Scrum) is a lightweight agile framework developed by (Larman & Vodde, 2017) for scaling Scrum to more than one team and SAFe (Scaled Agile Framework) is another approach developed by Dean Leffingwell for lean agile thinking and more visibly incorporation of scalable DevOps (Leffingwell, 2007; ScaledAgile, 2017).

Related but different from scaled agile practices and forms of organizational design is the concept of enterprise agility which is defined by Overby et al. as "the ability of firms to sense environmental change and respond readily" (2006, p. 121). Enterprise agility has its origins in management research and explains how to successfully navigate in turbulent environments (Overby et al., 2006). Enterprise agility is an organizational capability of continually sensing market change and responding appropriately (D'Aveni et al., 2010; Overby et al., 2006). These capabilities to "detect and seize market opportunities with speed and surprise" (Sambamurthy et al., 2003, p. 238) help firms to continually develop new competitive actions and gain sustainable competitive advantage (D'Aveni et al., 2010). Adopting agile practices and forms of organizational design can be perceived as one way to increase these capabilities related to enterprise agility (B. Fitzgerald & Stol, 2017; Highsmith, 2009; Kulak & Li, 2017).

In summary, we understand agility as a multidimensional concept (Abrahamsson et al., 2009; Holmström, Fitzgerald, Ågerfalk, & Conchúir, 2006) where speed (Lyytinen & Rose, 2006) and flexibility (Highsmith, 2009) are key elements.

IV.2.3 Generic Concepts of Fully Agile Organizations: Squads and Tribes

This This section briefly introduces basic agile concepts. The smallest unit of an agile organization – an agile team – is called a "squad": A squad is designed like a 'mini startup' and has overall product responsibility (Gonçalves & Lopes, 2014; Kniberg, 2012). A squad has all required resources and full authority to design develop, test, and deploy features. Squads are cross-functional, self-organized teams (Larman & Vodde, 2017; ScaledAgile, 2017). Squads usually consist of 8-12 permanent team members (Kim et al., 2016) and cover the following agile roles as outlined in Table 6.

Product owner (PO): The PO represents the customer and ensures that the product delivers business value. He acts as customer and prioritizes work. The PO defines and accepts the product's features.
Technical product owner (TPO): The TPO supports the PO to ensure that the product delivers business value. He substitutes the PO. He has the overall technical responsibility for the product.
Scrum master: The Scrum master ensures that Scrum is understood and enacted. He facilitates the Scrum methodology by supporting team events and coaching.
Agile coach: The agile coach is partly trainer and partly advisor helping agile teams to learn, apply, and to excel at agile practices. The agile coach usually serves several squads.
(Operative) team members: Design, build, test, integrate, maintain, and operate the product.
Experts: Contributor roles typically supported by specialists on part-time/short-term basis in specific tasks where the squad has no competencies.

Table 6. Summary of Agile Roles in Squads.

Finally, a "tribe" is a group of squads with similar business interest and responsibility for a product area consisting of several related products. A tribe usually consists of 8 to 12 squads and therefore contains up to 100 to 150 team members (Kim et al., 2016).

IV.2.4 Model 1: Spotify-Template for a Fully Agile Unit

This section introduces a generic agile unit serving as widespread template initially for startups or "born digital" companies. This model as applied by Spotify has been described first by Kniberg (2012) and has been further elaborated by Gonçalves and Lopes (2014). While Kniberg focuses on agile forms of organizational design applied by Spotify, Gonçalves and Lopes focus on agile practices and how LeSS has been implemented and adopted by Spotify. We refer to this template as 'model 1', a fully agile

unit that is built around products or services offered to clients or internal products or services like applications (e.g. Software as a Service) or IT-Infrastructure (e.g. Infrastructure as a Service). Model 1 relies on essential elements of agile practices like cross-functional and self-organized Scrum-teams.

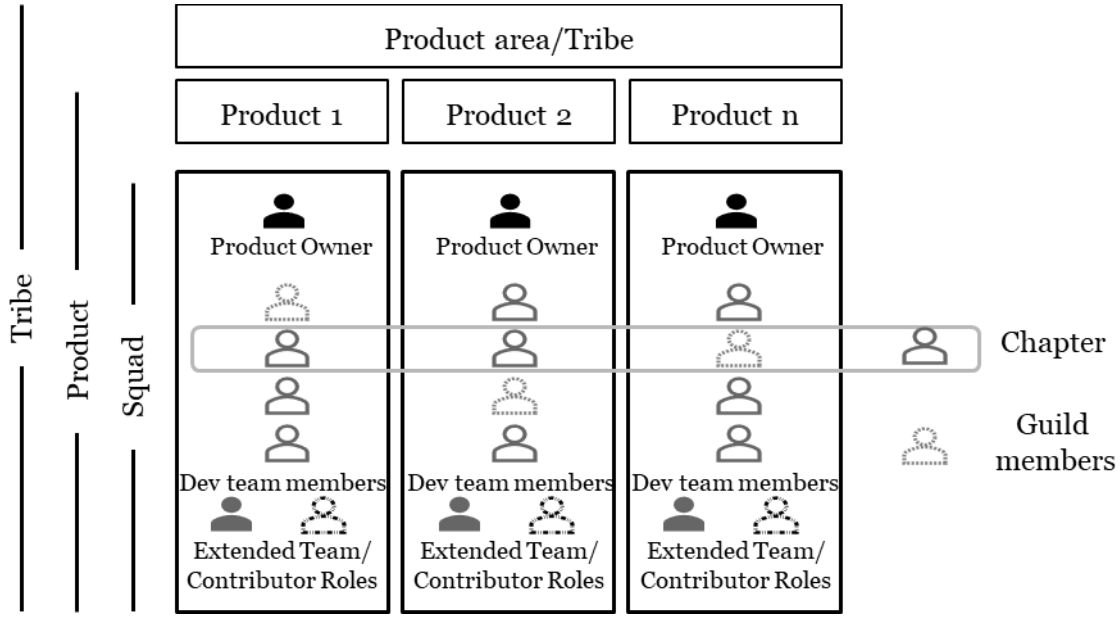

Figure 17. Model 1 – a Generic Agile Unit as Applied by Spotify.

Figure 17 depicts model 1: One or more squads represent a product while a tribe consists of a product area covering several products or a product family (Kniberg, 2012). A squad is led by the product owner who has overall functional product responsibility and represents the product (Kniberg, 2012). Each squad consists of all required resources to cover the entire product value chain (Gonçalves & Lopes, 2014; Kniberg, 2012). This typically includes the product owner, a technical product owner and a Scrum master together with team members taking care of planning, building, testing, integrating, and operating the product (Kim et al., 2016). Figure 17 additionally displays guilds and chapters: Chapters promote team collaboration and innovation and ensure methodological consistency across squads or tribes. Chapters usually form around functional skills and the chapter lead often serves as functional line manager for chapter members (Kniberg, 2012). Guilds are communities of members with shared interest; they are less formal than chapters and represent a unit for informal exchange and knowledge sharing around a topic of interest (Kniberg, 2012).

Model 1 comes with the following advantages: First, squads have all required resources to make product-related decisions. This so-called product-aligned delivery speeds up decisions and implementation significantly because all decisions can be made within the

squad (Tabib, 2013). Second, the issue of 'functional silos' is reduced since squads consist of all required resources to cover the product's value chain (Scott W Ambler, 2010). Third, team members have a mutual interest to 'not throw deliverables over the fence' since all squad members would suffer from a faulty product (Kim et al., 2016).

Model 1 does not come without disadvantages: While squads would ideally have all required resources for product delivery, squads are usually confronted with limited resources since they depend on specialists for specific needs (Kim et al., 2016; Kulak & Li, 2017). Furthermore, full autonomy of the squads for all product-related decisions include complete freedom also regarding IT-architecture or the employed DevOps toolchain. This might lead to a lack of standardization and synergies across squads.

IV.3 Research Methodology and Case Study Companies

This case study examines how traditional companies adapt and scale agile forms of organizational design. We have chosen an exploratory case study design with ten cases to maximize the chances of credible novelty (Langley & Abdallah, 2011) and to allow for cross-case analysis to shed light on various organizational configurations (Eisenhardt, 1989; Yin, 2009) applied by the case study companies.

The cases have been selected based on four criteria: First, to represent various industries avoiding a potential industry bias. Second, we identified the cases to represent different innovation assimilation stages to identify potential differences in organizational design. Third, we selected cases to which we had sufficient access to the case companies to explore this novel phenomenon of interest in depth. Finally, only companies have been considered that have already started implementing agile forms of organizational design according to scaled agile practices and structures like it is the case with model 1 (i.e. the Spotify template). Accordingly, out of 16 companies that were initially identified from an outside-in-perspective as potentially relevant, 10 companies could be selected for this case study. Consequently, companies in a transition stage towards fully agile forms of organizational design like bimodal IT have not been considered.

Case study insights were derived in personal interviews – a method which is recommended in exploratory research to allow comprehensive discussions (Langley & Abdallah, 2011). In each company, a minimum of one senior manager (e.g. department/unit head) and an employee from the operative level has been identified to gain a diverse perspective on agile forms of organizational design. Additionally, executives and consultants being involved in implementing agile practices or structures have been interviewed to further triangulate our findings. In total 32 interviews have

been conducted between November 2016 and February 2018 in either English or German. The interviews were conducted with a semi-structured questionnaire.

Questions were formulated mainly open-end to allow the interviewee the possibility to explore their experience and views in detail (Yin, 2009). Follow-up questions have been formulated for further clarification purposes. Each interview had a duration of 60-120 minutes and was carried out primarily personally in face-to-face meetings. If further details were required, additional interviews have been conducted by telephone/Skype. The interview results have been documented in detail in form of interview notes and, if permitted, in form of recorded interviews. All interviews were reviewed for consistency and completeness by another researcher that has not participated at the interviews. Recorded interviews were transcribed and analyzed with the computer-aided qualitative data analysis tool Atlas.ti.

An overview of the case study companies and conducted interviews is outlined in Table 7.

Industry/ code name of case study company	Head-quarter	Size [empl.]	Comp. age [years]	Inter-views [#]	Interviewees' position[1)]
Chemicals company ("ChemCo")	Germany	100,000	100+	5	(1); (2); (3)
Car manufacturer: IT department ("CarCo")	Germany	100,000	100+	7	(1); (2); (3)
Global bank ("FinCo")	UK	300,000	100+	2	(2); (3)
Services company ("ServicesCo")	USA	16,000	90+	2	(2); (3)
Online e-commerce company ("RetailCo")	Germany	50,000	50+	4	(1); (2); (3)
Global tools manufacturing company ("ToolsCo")	Liechten-stein	25,000	70+	2	(2); (3)
Global energy company ("EnergyCo")	Germany	40,000	100+	2	(2); (3)
Telecommunications company ("TelCo")	Switzer-land	17,000	20+	4	(2); (3)

Insurance company ("InsureCo")	Switzer-land	4,000	100+	3	(2); (3)
Global software company ("SoftwareCo")	USA	115,000	40+	1	(2)

1) (1) Executive level, e.g. CIO, CDO, CTO; (2) Manager level, e.g. unit head, product owner, area product owner; (3) Agile team member, consultant, agile coach.

Table 7. Overview and Specifics of Case Study Companies and Conducted Interviews.

IV.4 Preliminary Results

Based on the preliminary findings of this ongoing research, we present in the following section two modifications of the so-called Spotify template (i.e., model 1) that were adopted by the case study companies. We refer to these models as model 2 and model 3 (both see Figure 2).

IV.4.1 Model 2: Fully Agile Unit with Cross-Product Support

Model 2 as outlined in Figure 18 aims at addressing the perceived disadvantages of model 1 by adding shared cross-product functions – so called 'shared services tribes'.

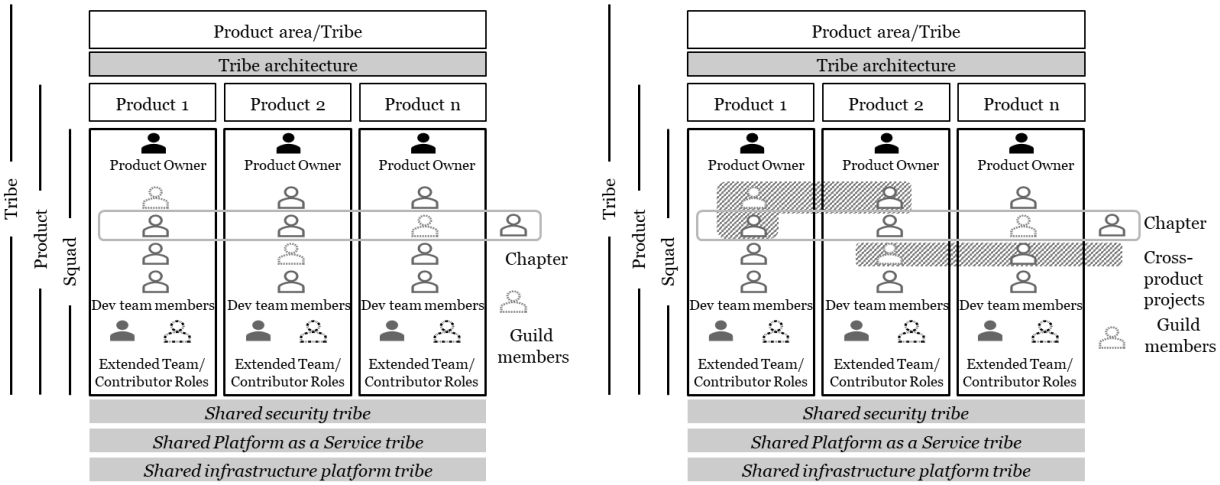

Figure 18. Fully agile unit (left model 2 – with shared services tribes, right model 3 – with cross-product projects).

Differences of model 2 compared to model 1 are shown in Figure 18 on the left side in shaded grey. FinCo as an industry leader in adopting agile practices and forms of organizational design implemented model 2 already in 2013. Model 2 has been adopted with some minor modifications by CarCo, ServicesCo, RetailCo, ToolsCo, Telco, InsureCo, and SoftwareCo to address issues of sharing critical resources and to ensure

common standards across tribes: A 'tribe architect' ensures that all squads within a tribe follow the same architectural standards, use the same DevOps toolchain for software development. Similarly, shared services tribes offer their services across tribes to ensure efficient allocation of scarce resources that are either needed only occasionally by squads or that are required at several squads.

Observed advantages of model 2 in addition to model 1 include an optimized resources allocation of shared services across tribes and a higher standardization due to shared standards and tools. We observed especially at FinCo that a cross-product tribe architect facilitates sanity across the product landscape regarding questions like which applications to shut down, what do develop, merge, or eliminate. Furthermore, product area responsibility at FinCo owns the quality of service of key customer journeys allowing for a seamless customer experience across products.

Model 2 comes with the disadvantage that alignment with cross-functional/shared services tribes might slow down product-aligned delivery since the product owner needs to align with the cross-functional/ shared services tribes. We observed related issues at CarCo, ChemCo, FinCo, InsureCo, RetailCo, ServicesCo, and TelCo that were in constant fine-tuning regarding which services to be provided out of shared services tribes and which to keep in product tribes.

IV.4.2 Model 3: Fully Agile Unit with Cross-Product Projects

Model 3 as outlined in Figure 18 on the right side further specifies model 2 and takes projects into account. We understand a project as a temporary organization being unique, novel and transient (Turner & Müller, 2003). In this sense, a project has a defined project objective, a start- and an end-date and is managed centrally by a dedicated project manager involving resources from various units. In a fully agile setting, all resources are allocated to squads. Consequently, projects would have to be staffed with squad team members dedicating some of their time to a project. The question of how to handle projects in a fully agile setting has been discussed in detail at CarCo, ChemCo, and RetailCo. ChemCo was the only company staying with model 3 whereas CarCo adopted it but returned to model 2 later and RetailCo discussed but not adopted it.

In a non-agile setting, functional organizations and projects play a key role for innovation (Gemünden, 2014) and can be handled comparatively easily since all involved units provide dedicated project resources. Contrary, in a fully agile setting, all resources are organized according to squads where the team allocates resources

according to feature prioritization by the product owner in a self-organized way. In this setting, squad sprint planning usually assumes full availability of all squad team members. Consequently, projects staffed with resources across products ("cross-product projects") from several squads are prone for resources conflicts between the squad's product owner and the project manager. This is especially true in cases of unclear or frequently changing project resources demand as it is often the case in projects dealing with uncertainty, novelty or innovation (Turner & Müller, 2003).

An alternative option to handle projects in a fully agile setting would be to staff them within members from squads or chapters. We have not observed both alternatives. The reasons might be twofold: First, projects handled within squads would work only in case that the squad can contribute all resources required for project delivery and project prioritization is in line with the product owner's priorities. But then a project would be just comparable to another product feature as it is certainly not the case with cross-product projects. Second, chapters usually promote team collaboration and innovation and ensure methodological consistency across squads or tribes. Consequently, chapters are not a suitable form for organizing work across squads as this would interfere with the squad's product feature prioritization by the product owner.

Advantage of model 3 additionally to model 2 is that it reflects projects and integrates them into a fully agile unit. Disadvantages are that conflicts like governance issues at matrix organizations result where a unit has both, a disciplinary (e.g. industry or region), and functional reporting line. Matrix organizations typically resolve reporting line conflicts by defining a solid and a dotted reporting line clearly indicating the leading dimension. We observed at CarCo and ChemCo that these prioritization conflicts are hard to be resolved in a fully agile unit where the project manager's priorities conflict with the interests of the product owner. In line with these findings, we observed that FinCo or ServicesCo tried to avoid the initiation of projects at all: Projects were staffed with external resources exclusively for reasons of flexibility and to avoid resource conflicts with squads.

IV.5 Conclusion and Discussion

As agility is vital to innovation and performance in rapidly changing market environments (Sambamurthy et al., 2003), enterprises aim at increasing agility as strategic capability (Highsmith, 2009). While agile practices and forms of organizational design are widespread at startups or "born digital" companies like Amazon, Google, or Facebook (Tumbas et al., 2017a), traditional companies started to adopt agile practices

and forms of organizational design just recently. Furthermore, agile practices or forms of organizational design have been perceived mainly as only suitable to startups or small units with co-located software developers in non-safety critical context (Ambler 2001). Consequently research focused on the software development function (B. Fitzgerald & Stol, 2017).

Accordingly, our research is motivated by the lack of empirical evidence on how traditional enterprises adopt agile forms of organizational design and extend and scale them to their needs. An exploratory case study with ten global cases has been conducted to gain insights into the current state of adopting agile forms of organization at enterprises.

Preliminary results reveal that companies are currently adopting agile forms of organizational design at large scale. Model 1 is a template for a generic agile unit relying on scaled agile frameworks such as LeSS or SAFe and is applied by Spotify. It serves as a frequently used template for implementing agile forms of organizational design and is a common starting point for turning into agile forms of organizational design. Since model 1 is closely related to startups or "born digital" companies, our study provides evidence for business units at enterprises outside IT adopting this model as it is for instance the case with the recently established autonomous driving unit of CarCo. As such, we provide empirical evidence for the adoption of agile forms of organizational design at large scale in companies irrespective of size or industry. Furthermore, we have extended model 1 by two others (model 2 and model 3) reflecting specific needs of enterprises when adopting and scaling agile forms of organizational design.

This study does not come without its limitations: We have identified ten cases to be as representative as possible for traditional enterprises adopting agile forms of organizational design. Selected cases might not be fully representative for companies of all industries and sizes. Furthermore, except for FinCo and InsureCo, most case study companies are at a comparatively early innovation assimilation stage in the sense that agile forms of organizational design have been implemented just recently. During research, most case study companies were in the constant fine-tuning regarding the adopted agile practices and forms of organizational design. Consequently, the presented agile forms of organizational design are snapshots of the current state of agile transformation during time of our research with a high likelihood that adopted agile forms of organizational design will be further fine-tuned and extended over time.

While this study is part of a larger research endeavor on how traditional companies adopt and scale agile practices and forms of organizational design, we aim at extending our research specifically to: (1) examining specific challenges resulting for traditional enterprises from adopting agile forms of organizations, (2) identifying migration paths for how agile forms of organizational design are enhanced over time, and (3) exploring how the scaling of agile forms of organizational design can possibly unlock organization-wide capabilities such as enterprise agility.

Despite of significant challenges imposed by adopting and scaling agile forms of organizational design, agile practices and forms of organizational design seem to be more than a short-term, transitory trend and are likely to play an important role as companies seek to increase speed and flexibility in response to rapidly changing market environments. It remains striking to learn how agile forms of organizational design are adopted and enhanced by traditional businesses to increase enterprise agility.

V: How Enterprises Adopt Agile Forms of Organizational Design: A Multiple-Case Study

Title	How Enterprises Adopt Agile Forms of Organizational Design: A Multiple-Case Study
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Figure 19. Bibliographic Information for Article V

Abstract. The question of how to increase speed and flexibility in times of digital disruption is essential to almost any company. While previous research mainly addresses agility in the context of information systems development, as form for organizing startups or "born digital" companies, little knowledge exists about the adoption of agile practices and structures at established enterprises. With an exploratory study of fifteen global cases, we aim at examining how established enterprises adopt and scale agile forms of organizational design. We found that (1) agile forms of organizational design are currently adopted by enterprises at large scale, (2) agile forms of organizational design are adopted not only by IT, but successively also by business units and in context outside information systems development, and (3) while Spotify's organization serves as a widespread template for a fully agile unit, enterprises adapt and fine-tune this template according to their needs and scale. We identified three additional models for fully agile forms of organizational design where a fully agile unit with cross-product support is the most frequently observed model.

Keywords: Agile Organization; Agile Practices; Agile Transformation; Bimodal IT, Enterprise Agility

V.1 Introduction

Digital transformation is ubiquitous and companies of almost any industry or size are under pressure to innovate on business models as new competitors create new products or services with the help of digital technologies (Kohli & Melville, 2018; Weill & Woerner, 2015). Thus, digital transformation imposes the need to continually sense and respond appropriately to frequently changing markets (D'Aveni et al., 2010; Overby et al., 2006) as new features need to be deployed in an ever-shorter timeframe in response to rapidly changing market environments (D'Aveni et al., 2010; Overby et al., 2006). In consequence, more and more companies adopt agile practices and forms of organizational design to increase speed and flexibility and to, thus, increase their agile capabilities (Highsmith, 2013; Rigby, Sutherland, & Noble, 2018). Further, by adapting the organizational structures and processes accordingly, enterprises adapt their organizational systems towards providing a suitable accompanying organizational foundation for leveraging new emerging information technologies (Dremel et al., 2018). Despite these inherent advantages of agile forms of organizational design and agile practices, these are mostly widespread at startups or "born digital" companies like Amazon, Facebook or Google (Tumbas et al., 2017a). Established enterprises started the adoption of agile practices and related forms of organizational design just recently (Gerster et al., 2018, 2019).

Agile practices are inherently linked to information systems development (ISD) (Conboy, 2009; X. Wang et al., 2012) and were initially considered to be only suitable for small and co-located software development teams (Scott W Ambler, 2010; Dikert et al., 2016). To tackle digital transformation, the need to scale agile practices and their corresponding organizational structures beyond IT at the entire organization has emerged (Leffingwell, 2007; Reifer et al., 2003). Enterprises are now on the edge of adopting not only agile practices but also agile forms of organizational design to increase organizational agility (B. Fitzgerald & Stol, 2017; Kurapati et al., 2012). Consequently, organizations are successively moving away from transitional structures like bimodal IT where only parts of the organization are organized according to agile design principles towards structures where the entire organization follows fully agile forms of organizational design (Horlach et al., 2017; Kulak & Li, 2017; Roemer et al., 2017).

Despite the growing agility literature (Conboy, 2009; X. Wang et al., 2012), research on how established enterprises adopt and scale agile forms of organizational design calls for a deeper understanding of (1) the application of agile practices and structures outside of software development (Conboy, 2009; Kiely et al., 2017), (2) the applicability of agile

practices beyond small and co-located development teams (Abrahamsson et al., 2009), (3) the impact of adopting agile practices and structures at established enterprises (Gerster et al., 2018, 2019), (4) empirical evidence, their use, effectiveness, and challenges of scaled agile frameworks (Conboy & Carroll, 2019; Dikert et al., 2016), and (5) how organizations can be structured to maximize benefits of adopting agile practices and structures (Maruping et al., 2009).

This study aims at responding to these calls for research with the following research questions:

1. Which generic agile forms of organizational design can be observed at established enterprises?
2. How do established enterprises adapt generic agile forms of organizational design to scale and to match their needs?

While the adoption of agile practices or large-scale agile frameworks like LeSS, Nexus, SAFe or Scrum at Scale is out of scope of this study, we focus on generating insights on how established enterprises (i.e. no startups or "born digital" companies) adopt and scale agile forms of organizational design by drawing on a multiple-case study with fifteen cases from global companies across different industries.

V.2 Background

This section introduces the main theoretical concepts of relevance for this study. We refer to related research on the roots of agile practices and organizational design in ISD as well as related concepts in IS research like organizational ambidexterity and bimodal IT. In particular, we introduce the concept of product orientation as a central element for organizational design of fully agile units and explain the generic elements of fully agile units as exemplarily applied by Spotify. We refer to Spotify's agile organization as it serves as a widespread template for a fully agile unit at startups or "born digital" companies and is increasingly also adopted by established enterprises. To ensure a proper connection to the relevant literature and our addressed research gap we have limited ourselves to extant literature related to agile forms of organizational design. In detail, we have searched the data bases EBSCO, Google Scholar, and the Web of Science between 2016 and 2019 using search terms such as agile organization, agile practices, agile transformation, bimodal IT, and enterprise agility.V.2.1 Roots of Agile Practices and Forms of Organizational Design: Information Systems Development.

V.2.1 Roots of Agile Practices and Forms of Organizational Design: Information Systems Development

Agile practices can be seen as a response to challenges resulting from the traditional way of software development according to "Plan-Build-Run" (Royce, 1987) and the resulting separation between build and run (Rigby et al., 2016). Agile practices root in systems thinking and lean practices (Kulak & Li, 2017; Larman & Vodde, 2017; Leffingwell, 2007). Systems thinking is about changing our perspective to solve problems in new and unexpected ways (Deming, 2000). The Agile Manifesto is perceived as a practitioners' collection of best practices on agile ISD and aims at designing "better ways of developing software by doing it and helping others do it" (Fowler & Highsmith, 2001, p. 2). It applies principles of systems thinking to software development: Individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (Fowler & Highsmith, 2001).

Agile practices can be exemplarily characterized as follows: Formulation of value stories, removing complexity, shortening release cycles to incorporate customer feedback, and the estimation with story points to reduce effort estimation complexity (Conboy, 2009; Rigby et al., 2016; X. Wang et al., 2012). Agile practices aim, for instance, at clean code, pair programming and immediate customer feedback, test-driven development, automated testing, continuous deployment (B. Fitzgerald & Stol, 2017; Kulak & Li, 2017) and achieve their benefits through the synergistic combination of individual agile practices (B. Fitzgerald et al., 2006).

Agile practices and forms of organizational design have become an appealing option for companies to improve their performance, but these agile methods were originally designed for small and collocated teams (Dikert et al., 2016). Similarly, challenges emerge as introducing agile practices in the IT function alone is not sufficient and requires "a more holistic approach […] than one which is merely focused on continuous integration of software" (B. Fitzgerald & Stol, 2017, p. 176) to increase performance at the entire organization. Consequently, the benefits of introducing agile practices and forms of organizational design will be sub-optimal if not complemented by an agile approach in related functions outside IT (Leffingwell, 2007; Overby et al., 2005).

As organizations scale, so do IT development and operations units. While they may initially be co-located with close communication links, increased team size and a stricter separation of responsibilities can weaken such links (Boehm & Turner, 2005; Swartout,

2014). Practitioners made several attempts to scale agile practices to the enterprise level by adapting agile practices known from ISD and new agile forms of organizational design. To address the inherent challenges of implementing scaled agile practices at larger organizations, frameworks for scaled agile practices emerged (Dyba & Dingsoyr, 2009): LeSS (Large Scale Scrum) is a lightweight agile framework developed by Craig Larman and Bas Vodde for scaling Scrum to more than one team (Larman & Vodde, 2017) and SAFe (Scaled Agile Framework) is another approach developed by Dean Leffingwell for lean agile thinking and more visibly incorporating of scalable DevOps (Leffingwell, 2007; ScaledAgile, 2017). A variety of agile practices has emerged with Extreme Programming, Kanban, Lean Startup, LeSS, Nexus, SAFe, and Scrum at Scale as the most prominent ones (Versionone, 2018). The adoption of agile practices and forms of organizational design at large scale is faced with challenges like communication issues. A lack of flexibility or openness and willingness to transform is besides of coordination challenges an often underestimated prerequisite for a successful implementation (Conboy & Carroll, 2019). Furthermore, agile practices can only be scaled to a limited extent (Paasivaara, Lassenius, & Heikkilä, 2012).

V.2.2 Increasing Speed and Flexibility through the Adoption of Agile Practices

Key issues inherent to traditional ISD are that developing complete functional specifications is usually (1) not economical since it requires considerable effort before implementation starts (Book et al., 2012); (2) not feasible since learnings of first iterations of feature development cannot be incorporated (Kim et al., 2016); and (3) not helpful since the client usually remains unable to express all requirements in sufficient complete and consistent detail up front (Kulak & Li, 2017). Consequently, in situations of frequent changes or unclear requirements endless renegotiation of requirements may result when traditional approaches to ISD are applied (Pries-Heje & Pries-Heje, 2014).

Contrary, agile practices can help to address some key issues of traditional ISD: First, the recognized lack of helpfulness of a complete up-front specification of functional requirements has led to the rise of agile software development methods such as Scrum (Schwaber & Beedle, 2002) where voluminous specifications are replaced by lean specifications to achieve simple design (Book et al., 2012). Second, sprints are planned according to business priorities as specified by the product owner as a representative for the client's business priorities (X. Wang et al., 2012). Third, small releases are deployed in short, iterative sprint cycles of two to three weeks for an early go-to-market with gradual improvement (Hekkala et al., 2017). Short sprint cycles ensure that new features

can be deployed early, shipped iteratively, and piece by piece (Austin & Devin, 2009). Furthermore, changing requirements can be taken into account within a reasonably short timeframe (Ågerfalk et al., 2009). Fourth, continuous testing and integration ensure that new functionality will be tested and deployed instantaneously without waiting for big release bundles increasing the risk at integration tests (B. Fitzgerald & Stol, 2017). Fifth, pair programming ensures a quality check already during coding as one developer codes and another checks quality (B. Fitzgerald & Stol, 2017). Sixth, distributed leadership and decision-making speed up decision making and ensure that required information is readily available empowering self-organizing teams (Hekkala et al., 2017). Seventh, daily stand-ups and retrospectives serve as supporting organizational culture as they facilitate team communication on sprint status and foster learning and continuous improvement (Hekkala et al., 2017; Recker et al., 2017).

Applying these agile practices to ISD has three implications: First, time-to-market for critical features can be reduced as features with high business impact can be prioritized by the product owner (Ågerfalk et al., 2009). Second, product quality can be increased due to early and automated testing, incorporated quality checks due to pair programming, communication and mutual feedback (B. Fitzgerald & Stol, 2017). Third, flexibility for deployment of frequently changing features can be increased due to short, iterative sprint cycles and lean requirements specification (Coram & Bohner, 2005).

An agile and iterative approach to ISD can therefore – by design – reduce risk and uncertainty and can protect clients from things they may not know (Arbogast et al., 2012). Furthermore, an agile approach limits both the scope of the deliverable and extent of the payment and allows for inevitable change and focuses negotiations on the neglected area of delivery (Arbogast et al., 2012). In consequence, agile practices can contribute in increasing speed by reducing time-to-market of critical features and in increasing flexibility (Conboy, 2009; X. Wang et al., 2012).

V.2.3 Ambidexterity, Bimodal IT and Enterprise Agility as Related IS Concepts

The term bimodal IT was initially coined by practitioners and is related to ambidexterity (Joehnk et al., 2017). Ambidexterity is the ability of simultaneously pursuing exploitation and exploration (O'Reilly & Tushman, 2008; Raisch et al., 2009). Exploration is related to innovation capabilities and to "recombine potential resources in novel ways to create new capabilities and opportunities" (Lee et al., 2015, p. 400) whereas exploitation is related to the efficient leverage and refinement of existing resources through known processes (Lee et al., 2015; March, 1991). Against this

backdrop, bimodal IT refers to ambidexterity through the ability of managing two separate but coherent working styles: One focusing on exploration, the other on exploitation (Bygstad, 2015). Companies engage in bimodal IT to increase IT agility, IT exploratory capabilities, and the need for a structured business-IT alignment (Haffke et al., 2017b; Horlach et al., 2016). Bimodal IT organizations can be perceived as a transitional stage towards fully agile forms of organizational design (Horlach et al., 2017).

Finally, related but different from scaled agile practices and forms of organizational design is the concept of enterprise agility which is defined by Overby et al. as "the ability of firms to sense environmental change and respond readily" (2006, p. 121). Enterprise agility has its origins in management research and explains how to successfully navigate in turbulent environments (Overby et al., 2006). Enterprise agility is an organizational capability of continually sensing market change and responding appropriately (D'Aveni et al., 2010; Overby et al., 2005). These capabilities to "detect and seize market opportunities with speed and surprise" (Sambamurthy et al., 2003, p. 238) help firms to continually develop new competitive actions and gain sustainable competitive advantage (D'Aveni et al., 2010). Adopting agile practices and forms of organizational design can be perceived as one way to increase these capabilities related to enterprise agility (Highsmith, 2013; Kulak & Li, 2017).

In summary, we understand agility as a multidimensional concept (Abrahamsson et al., 2009; Holmström et al., 2006) where speed (Lyytinen & Rose, 2006) and flexibility (Highsmith, 2009) are key elements.

V.2.4 Product-orientation as a Key Feature of Agile Practices and Structures

The concept of product aligned delivery is of high importance for agile organizations. Agile units need to reduce the effects of functional orientation where focus is on cost optimization by achieving scale and efficiency (Kim et al., 2016). In consequence, market orientation needs to be strengthened to optimize for speed and flexibility (Kim et al., 2016; Kulak & Li, 2017). This can be achieved by having small teams empowered with all required resources for decision making working independently on features that can be shipped in short, iterative cycles to incorporate early customer feedback (Kim et al., 2016; Przybilla, Wiesche, & Krcmar, 2018; Recker et al., 2017). By this, market-oriented teams (i.e. product or feature teams) are responsible not only for feature development but also for concepting, sourcing, testing, deploying and operations including maintenance and updates to support the product's entire value chain from

conception to retirement (Kim et al., 2016). The break-up of a functional organization into small product teams reduces time-to-market as they can deploy their loosely coupled components independently into production (Humble & Molesky, 2011). Furthermore, establishing stable teams with an ongoing funding to take ownership of the product's strategy and roadmap increases delivery consistency over time as resources are constantly assigned to product teams and are not – as it is usually the case with traditional approaches to ISD – re-allocated from project to project (Kim et al., 2016).

There are various approaches to designing products in agile organizations. Products can be formed around product or services offerings to internal or external clients or can be formed around specific features, processes or technologies (Kim et al., 2016; Kulak & Li, 2017). In consequence, the shift from a functional organization to an organization adopting a market-oriented perspective focusing on products can be perceived as essential for successfully establishing agile forms of organizational design (Highsmith, 2009; Kulak & Li, 2017).

V.2.5 Generic Elements of a Fully Agile Unit

This section briefly introduces basic agile concepts. The smallest unit of a fully agile structure – an agile team – is called "squad" or product/feature team and is outlined in Figure 20.

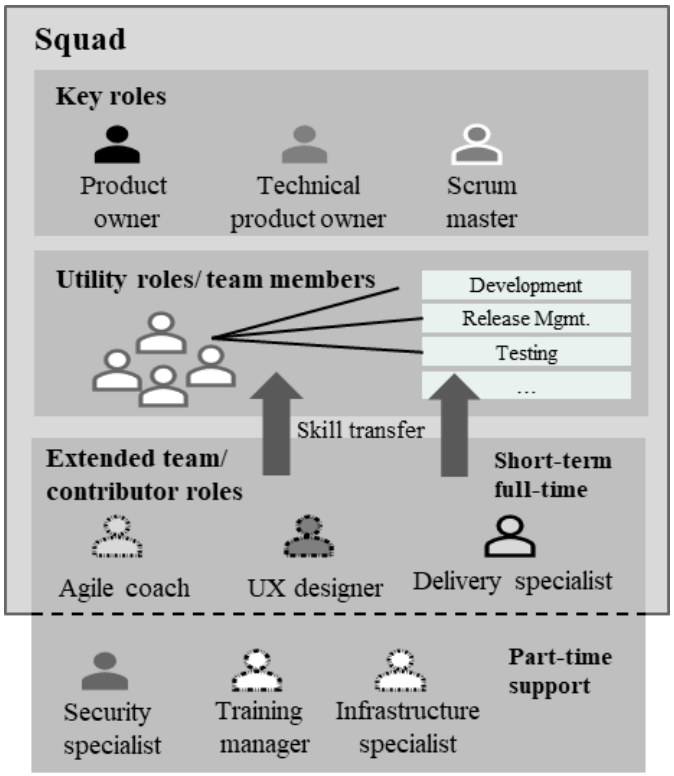

Figure 20. Basic agile team layout: The squad

A squad is designed like a "mini startup" and has overall product/feature responsibility and is therefore often called product or feature team (Gonçalves & Lopes, 2014; Kniberg, 2012). A squad has all required resources to design, develop, test, and deploy features and is a small cross-functional, hierarchically flat and self-organized team (Kniberg, 2012). The aim is to keep the team size small and to follow the "two-pizza team" rule, i.e. a team only as large as can be fed with two pizzas – usually about five to ten team members (Kim et al., 2016). To facilitate communication within the team, members are usually collocated and sitting together. They are self-organizing and decide on their own way on how to work as they are basically free of hierarchies (Kniberg, 2012). The most important agile team roles that are usually present in every squad are outlined in Table 8.

Product owner (PO): The PO represents the customer and ensures that the product delivers business value. He acts as customer and prioritizes work. The PO defines and accepts the product's features.
Technical product owner (TPO): The TPO supports the PO to ensure that the product delivers business value. He substitutes the PO. He has the overall technical responsibility for the product. The PO takes the business value of features as well as technical aspects into account and focuses on desired outcomes.
Scrum master: The Scrum master ensures that Scrum is understood and enacted. He facilitates the Scrum methodology by supporting team events and coaching.
Agile coach: The agile coach is partly trainer and partly advisor helping agile teams to learn, apply, and to excel at agile practices. He coaches team members to continuously improve and facilitates learning of the team members. An agile coach usually serves several squads depending on team size and experience of teams related to agile practices.
Operative team members: The operative team members take care for designing, developing, testing, integrating, maintaining, and operating of the product. Team members are staffed according to necessity of the product team with the objective that all required skills are represented within the squad.
Experts: Experts typically support in a specialist role on part-time/short-term basis in specific tasks where the squad has no competencies. They are not permanent members of the squad and are called-in on a need's basis.

Table 8. Summary of Agile Roles in Squads

Finally, a "tribe" is a group of squads with similar business interest and responsibility for a product area consisting of several related products. A tribe consists usually of eight

to twelve squads and therefore contains up to 100 to 150 team members (Kim et al., 2016).

V.2.6 Model 1: Spotify-template/Fully Agile Unit

The following section introduces a template for a fully agile structure that has been initially designed by startups and "born digital" companies (Gonçalves & Lopes, 2014; Kniberg, 2012). This model as applied by Spotify has been described first by Kniberg (2012) and has been further elaborated by Gonçalves and Lopes (2014). While Kniberg focuses on agile forms of organizational design applied by Spotify, Gonçalves and Lopes focus on agile practices and how LeSS has been implemented and adopted by Spotify. We refer to this template as 'model 1', a fully agile unit built for product-orientation.

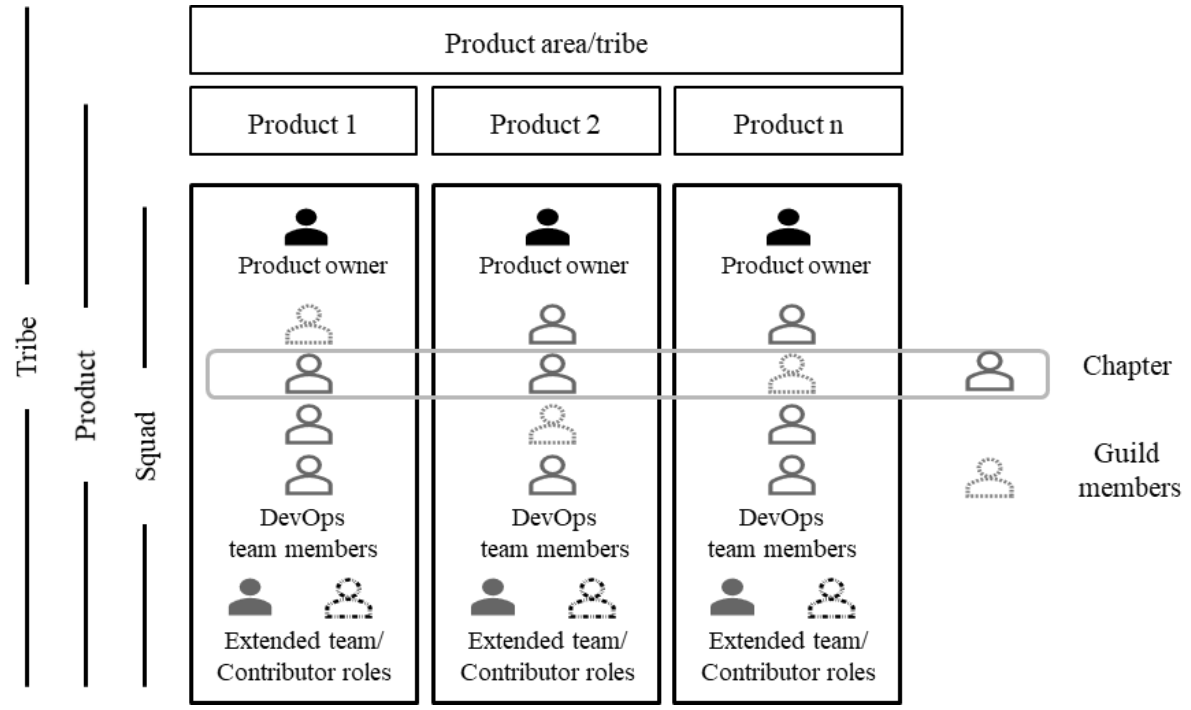

Figure 21. Model 1 – a generic agile unit as applied by Spotify

Figure 21 shows model 1: One or more squads represent a product while a tribe consists of a product area covering several products or a product family (Kniberg, 2012). A squad is led by the product owner who has overall product responsibility and represents the product towards the customer (Kniberg, 2012). Each squad consists of all required resources to cover the entire product value chain (Gonçalves & Lopes, 2014; Kniberg, 2012). This typically includes the agile roles as outlined in the previous section introducing generic elements of a fully agile unit.

Furthermore, an area product owner is responsible for consistent product features across all products of the related product area and ensures an overall seamless customer experience. An area product owner with functional responsibility for the entire tribe ensures frequent alignment between the squads' product owners to facilitate a seamless customer experience across products.

Figure 21 further contains chapters and guilds: Chapters promote team collaboration and innovation and ensure methodological consistency across squads or tribes (Gonçalves & Lopes, 2014). Chapters usually form around functional skills (e.g. testing) or technical skills (e.g. machine learning) and the chapter lead often serves as line manager for chapter members (Kniberg, 2012). Chapter members meet regularly to discuss their area of expertise, specific issues and lessons learned (Kniberg, 2012). Contrary, guilds are communities of members with shared interest; they are less formal than chapters and represent a unit for informal exchange and knowledge sharing around a topic of interest (Kniberg, 2012). Team members can flexibly switch between guilds according their specific interest or topic they are currently working on (Kniberg, 2012).

Despite its origin at startups or "born digital" companies, model 1 is in the meantime also popular at established enterprises due to its simplicity and ease of customization (Kim et al., 2016; Versionone, 2018). Furthermore, model 1 is not limited to IT departments but can also be applied to almost any other business unit with clear responsibility for a product or service (Kniberg, 2012).

Model 1 comes with the following advantages: First, squads have all required resources to make product-related decisions. This so-called product-aligned delivery speeds up decisions and implementation significantly because all decisions can be made within the squad (Fitzgerald & Stol, 2017). Second, the issue of "functional silos" is reduced since teams consist of all required resources to cover the product's value chain (Ambler, 2010). Third, team members have a mutual interest to "not throw deliverables over the fence" since all squad members would suffer from a faulty product (Kim et al., 2016).

Disadvantages of model 1 are as follows: While squads would ideally have all required resources for product delivery, they are usually confronted with limited resources and often do not have all required resources available since squads depend on specialists for specific needs (Kim et al., 2016; Kulak & Li, 2017). Furthermore, full autonomy of the squads for all product-related decisions include complete freedom also regarding IT-architecture or the employed DevOps toolchain. This is usually not the case and might lead to a lack of standardization and synergies across products (Kulak & Li, 2017).

V.3 Research Methodology and Introduction to the Case Study Companies

This study aims at analyzing and comparing the adoption of agile forms of organizational design at established enterprises. We have chosen an exploratory case study design with fifteen global cases to maximize the chances of credible novelty (Langley & Abdallah, 2011) and to allow for cross-case analysis shedding light on various organizational configurations applied by the case study companies (Eisenhardt, 1989; Yin, 2009).

The case study companies were selected based on five criteria: First, we aimed at companies to represent established enterprises (i.e. no startups or "born digital" companies like Amazon, Facebook or Google) of various industries and size classes to avoid potential bias. The smallest company in our sample has 4,000 employees and the youngest is 20 years old. On average, the case study companies exceed 63,800 employees and are in business for more than 79.3 years. Second, we aimed especially for business units outside corporate IT applying agile practices and forms of organizational design as it is the case with CarCo-Drive, parts of RetailCo, and VehicleCo to identify possible differences compared to IT departments. Third, we tried to identify cases of different adoption stages regarding agile forms of organizational design to have sufficient empirical evidence to fully explore potential migration paths of agile forms of organizational design in detail. Fourth, we selected cases to which we had sufficient access to get interviews to explore this novel phenomenon of interest in sufficient depth. Finally, only companies have been considered that apply already agile practices and forms of organizational design in a scaled setting as it is the case with scaled agile frameworks like LeSS or SAFe.

Table 9 provides an overview of the case study companies and conducted interviews.

Case ID	Industry	Headquarter location	Cluster[1]	Size[2]	Company age[3] [years]	Dept	Interviews [#]	Interviewees' position[4]
"CarCo-Drive"	Automotive	Germany	IV	100+	100+	Bus.	8	(2); (3)
"CarCo-IT"	Automotive	Germany	I	100+	100+	IT	7	(1); (2); (3)
"Chemco"	Chemistry	Germany	II	100+	100+	IT	5	(1); (2); (3)
"EnergyCo"	Energy	Germany	I	40	100+	IT	2	(2); (3)
"FinCo"	Bank	UK	III	65	100+	IT	2	(2); (3)

"InsureCo"	Insu-rance	Switzer-land	II	4	100+	IT	3	(2); (3)
"MedtechCo"	Medi-cal	Germany	II	100+	100+	IT	4	(2); (3)
"RailCo"	Trans-porta-tion	Germany	II	100+	20+	IT	3	(2); (3)
"RetailCo"	Retail	Germany	II; IV	50	50+	IT; Bus.	3	(1); (2); (3)
"ReinsureCo"	Rein-surance	Germany	I	40	100+	IT	2	(2)
"ServicesCo"	Serv.	USA	II	16	90+	IT	2	(2); (3)
"Software-Co"	IT	USA	III	100+	40+	IT	2	(1); (2)
"TelCo"	TelCo	Switzer-land	II	17	20+	IT	4	(2); (3)
"ToolsCo"	Manu-factu-ring	Liechten-stein	III	25	70+	IT	2	(2); (3)
"VehicleCo"	Auto-motive	Germany	IV	100+	100+	Bus.	3	(2); (3)

1) I: Ex-bimodal; II: Fully agile from the beginning; III: Agile pioneers; IV: NewCo or new business unit.
2) in '000 [employees]. For reasons of confidentiality, the exact number of employees was not specified if it exceeds 100,000.
3) For reasons of confidentiality, the exact company age was not specified if it exceeds 100 years.
4) (1) Executive level, e.g. CIO, CDO, CTO; (2) Manager level, e.g. unit head, product owner, area product owner; (3) Agile team member, consultant, agile coach.

Table 9. Overview and specifics of case study companies and conducted interviews

Following the definition of Dikert et al., (2016) we assume "large scale" to denote organizations with 50 or more people working according to agile principles or at least six fully agile teams. Out of a long-list of 25 companies that were initially identified from an outside-in-perspective based on their relevance for their industry as established enterprises and based on publicly available information, fifteen enterprises were identified to fulfill all selection criteria. In an iterative process we analyzed each case and reached with our three last cases theoretical saturation, i.e., these additional cases did not lead to new empirical data (Morse, 2015).

Case study insights were derived in personal interviews – a method which is recommended in exploratory research to allow comprehensive discussions (Langley & Abdallah, 2011). In each company, a minimum of one senior manager (e.g. department/unit head) and an employee from the operative level has been identified to get a diverse view on how agile forms of organizational design have been implemented. Additionally, executives and consultants facilitating agile transformation have been interviewed to further triangulate our findings. Internal information from the case study companies like presentations, memos, or e-mails with relevant communication related to agile practices or forms of organizational design have been considered as additional background information if available.

In total 52 interviews have been conducted between November 2016 and March 2019 in either English or German. The interviews were conducted based on a semi-structured interview guideline following the recommendations of Schultze and Avital (2011) and Strauss and Corbin (1998) to ground the interviews in the participants' own experiences and to allow the theory to emerge from data.

Follow-up questions have been formulated for further clarification purposes. Each interview had a duration of 60-120 minutes and was carried out primarily personally in face-to-face meetings. If further details were required, additional interviews have been conducted by telephone or the communication software Skype. The interview results were documented in detail in form of interview notes and, if permitted, in form of recorded interviews. The interviews were coded and reviewed for consistency and completeness by another researcher that has not participated at the interviews. The coding procedure consisted of open, axial and selective coding to inductively identify emerging concepts and themes within and across our case studies (Myers & Newman, 2007). Transcripts have been checked for completeness and have been analyzed separately from one another by different members of the research team. The qualitative data analysis software Atlas.ti supported the coding procedure, facilitating comparison of the coding results and memos as well as checking. Where interpretations between coders diverged, perspectives were discussed iteratively to reach a consensus and to ensure consistency of coding and interpretation.

To facilitate the understanding for the variety of the case sample, case study companies have been grouped according to the following four clusters: Cluster I ("ex-bimodal") represents companies that started their journey of adopting agile forms of organizational design with an initially bimodal IT setting. Companies in cluster II ("fully agile from the beginning") started their agile journey right from beginning with adopting fully agile

forms of organizational design. They have skipped an initially bimodal IT stage where agile units are established in parallel to non-agile units. Cluster III ("agile pioneers") represents companies that pioneered in their industry with an unusually early adoption of agile practices and forms of organizational design. Like companies in cluster II, they typically started with the adoption of fully agile forms of organizational design right from beginning and have skipped bimodal IT settings completely. Cluster IV ("NewCo or new business unit") contains enterprises that established either a new subsidiary or a new business unit and decided to adopt fully agile forms of organizational design right from the beginning in the respective new unit. Cluster IV is also a typical setting for adopting agile practices and forms of organizational design outside corporate IT in business units as it is the case with all companies in cluster IV.

Cluster I ("ex-bimodal") consists of the following three companies: CarCo-IT, EnergyCo and ReinsureCo: CarCo-IT represents the Group IT consisting of almost 4,000 employees of a leading German car manufacturer. CarCo's IT department was an early adopter of bimodal IT and introduced agile units in parallel to non-agile units within the same department. CarCo-IT decided in 2017 to move from a bimodal IT structure towards a fully agile setting for the entire IT department and reorganized according to products. EnergyCo adopted a bimodal IT structure in 2015 and moved towards a fully agile structure in 2016 as part of adopting digital technologies to foster innovation with new digital products and services. Likewise, ReinsureCo started its agile journey by introducing bimodal IT in 2015 with a successive migration towards a fully agile setting of its IT department in 2018. ReinsureCo's motivation was to selectively innovate with a newly founded digital hub to gather first experience with digital technologies and their impact of the existing organization.

Cluster II ("fully agile from the beginning") consists of seven companies: ChemCo, InsureCo, MedtechCo, RailCo, RetailCo (in part), ServicesCo, and TelCo. ChemCo, a major German chemicals company adopted a fully agile form of organizational design in their IT department to complement the launch of product orientation in 2016. InsureCo, the Swiss subsidiary of a major European insurance company started as early as in 2015 with the reorganization of its IT department according to fully agile forms of organizational design. Business units were intended to follow regarding the adoption of fully agile organizations but have not started their transformation when interviews have been conducted in 2017. In 2018, InsureCo was – besides of FinCo – one of the most experienced and advanced case study companies regarding being agile with an advanced adoption of agile practices in their corporate culture. MedtechCo, a major German

medical company started to reorganize its IT department in 2018 according to product orientation in the infrastructure division to prepare for a fully agile setting of their IT department. The applications division is scheduled to follow with the reorganization according to products in 2019. RailCo, a major European transportation and logistics company started to introduce product orientation in its IT subsidiary in 2017 and decided to aim for a fully agile form of organizational design right from the beginning. RetailCo adopted fully agile forms of organizational design early in its IT department starting in 2014. While its business division has been allocated to Cluster IV as they established new business ventures outside IT exclusively according to fully agile forms of organizational design exclusively, we decided to allocate RetailCo's IT division to cluster II as RetailCo's IT adopted fully agile forms of organizational design within their existing IT department. ServicesCo, an US-based professional services company started its agile transformation in 2016 adopting a fully agile setting in its IT department. Finally, TelCo, a leading Swiss telecommunications company started its agile transformation in 2016 in the IT department according to fully agile forms of organizational design and skipped a bimodal IT setting as well.

Cluster III ("agile pioneers") consists of three companies: FinCo, SoftwareCo, and ToolsCo. As a truly global player, FinCo was one of the first banks to adopt agile practices and forms of organizational design as early as in 2012 motivated by the intention to foster innovation and to disrupt the financial services industry with new digital services offerings. SoftwareCo, an US-based leader in the software industry adopted a "cloud and mobile first" strategy when its new CEO has been appointed in 2014. As a software company, SoftwareCo was especially exposed to agile ISD in its core business of software development. Consequently, SoftwareCo adopted a fully agile form of organizational design early as it is usually the case with "born digital" companies only. We decided to include SoftwareCo in this case study since – being for more than 40 years in business – we wouldn't consider SoftwareCo as typical "born digital" company taking the company's history as IT software vendor with a traditional business model of selling software licenses and maintenance into account. Finally, the tools manufacturer ToolsCo has a long history in disrupting its industry with business model innovation. Likewise, ToolsCo's IT department has a reputation for being an early adopter of new software solutions in the IT industry and consequentially also pioneered in adopting fully agile forms of organizational design.

Cluster IV ("NewCo or new business unit") consists of three companies: CarCo-Drive, RetailCo (partly) and VehicleCo. CarCo-Drive represents CarCo's car engineering unit

taking care for the development of an autonomous driving development IT-platform. It has been established as new business unit within the car engineering department of CarCo and is organized according to the scaled agile framework LeSS and consists currently out of approx. 900 employees. This unit seeks to develop own autonomous driving capabilities related to high and full autonomous driving (level 4 and 5) according to SAE's definition (Herrmann, Brenner, & Stadler, 2018; SAE, 2018) with intended deployment in serial production in 2021. The development platform will be used for programming, simulating and testing of the autonomous driving code to be deployed in cars. Likewise, RetailCo, a German online retailer with a proven track for innovation and entrepreneurship, started early to establish new business ventures as fully agile organizations exclusively. Consequently, corresponding business units of RetailCo have been allocated to Cluster IV. VehicleCo represents a business unit of the German car manufacturer VehicleCo that has been newly established to provide business analytics services to different business units at VehicleCo. Consequently, VehicleCo decided to establish this unit according to a fully agile form of organizational design.

V.4 Results

Based on the findings of this case study, we present in this section three models in addition to model 1 that we could observe. We refer to these models as model 2, 3, and 4 (see Figures 22-24).

V.4.1 Agile Forms of Organizational Design

Model 2: Fully agile unit with cross-product support

Model 2 addresses the disadvantages of model 1 by adding shared cross-product teams to a tribe. Squads usually do not have all resources required for product delivery as they sometimes depend on specialists for specific tasks that only temporarily occur. Likewise, it would not be efficient to keep resources with very specialized know how within a squad if their expertise in a specific subject matter would only be occasionally required in the respective squad while other squads would be occasionally in need of this special expertise as well. An example for a subject matter where occasionally special expertise is required is enterprise architecture or the selection of specific tools or software to innovate or develop new functionality.

Furthermore, in a scaled enterprise environment, alignment with non-product-related cross functional departments like Finance & Controlling, HR, Purchasing, Legal, etc. that are usually organized non-agile occurs temporarily and involves specific tasks or

processes beyond the usual day-to-day business of squad team members. Model 2 adds a cross-tribe team to the tribe taking care for overall architecture within the tribe. This unit ensures that basic architectural standards are followed by all squads to ensure architectural consistency and to facilitate synergies across the entire organization.

Additionally, shared services teams provide services to all squads within a tribe. Frequently observed examples for shared services teams at the case study companies include for instance a shared Infrastructure as a Service (IaaS) or a Platform as a Service (PaaS) team providing cross-tribe services related to infrastructure or applications.

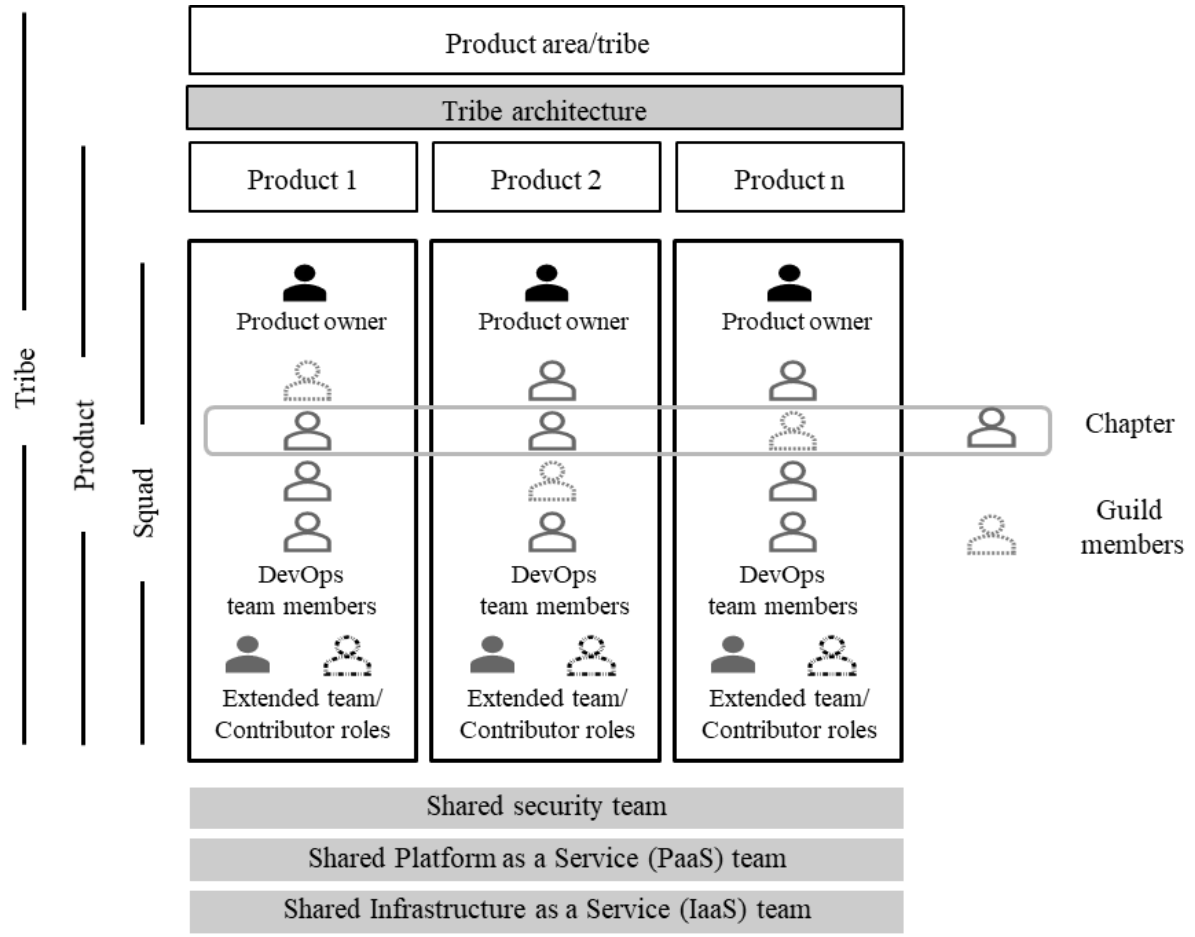

Figure 22. Fully agile unit (model 2 – with cross-functional teams)

The differences of model 2 compared to model 1 are shown in Figure 22 in light grey. FinCo as an industry leader in adopting agile forms of organizational design was the first of the case study companies adopting model 2 already back in 2012. Model 2 has been adopted with some minor modifications also by InsureCo, MedtechCo, RailCo, ServicesCo, SoftwareCo, TelCo, ToolsCo and partly RetailCo to address issues of shared resources allocation and to ensure standardization across squads within tribes: A

"tribe architect" ensures that all squads follow the same architectural standards, use the same DevOps toolchain for agile ISD and agile practices like Scrum, Kanban, Extreme Programming (XP), or Lean Startup. Similarly, shared services teams like Platform as a Service (PaaS) or Infrastructure as a Service (IaaS) teams offer their services across squads to ensure efficient resources allocations within the tribe.

Observed advantages of model 2 include an optimized resources allocation of shared services across squads and a higher standardization to ensure consistency and efficiency within a tribe. We observed especially at FinCo that a cross-product tribe architect facilitates sanity across the product landscape regarding the employed DevOps toolchain for agile ISD as the cross-product tribe architect has the ultimate power of decision with respect to architectural questions. Exemplarily, CarCo-Drive struggled with an initial lack of cross-product alignment regarding DevOps toolchain and architecture creating inconsistency between squads and a wide variety of different and redundant software and tools before adopting model 2.

Model 2 comes with the disadvantage that alignment with cross-functional/ tribes might slow down delivery due to the required alignment with cross-functional teams. We observed related issues at CarCo-Drive, FinCo, InsureCo, MedtechCo, RailCo, RetailCo, ServicesCo, and TelCo which were in constant fine-tuning regarding which services to be allocated in shared services teams or squads.

Model 3: Fully agile unit with cross-product projects

Model 3 – as outlined in Figure 23 – further specifies model 2 and takes the existence of projects in agile forms of organization into account. Differences to model 2 are displayed in shaded grey.

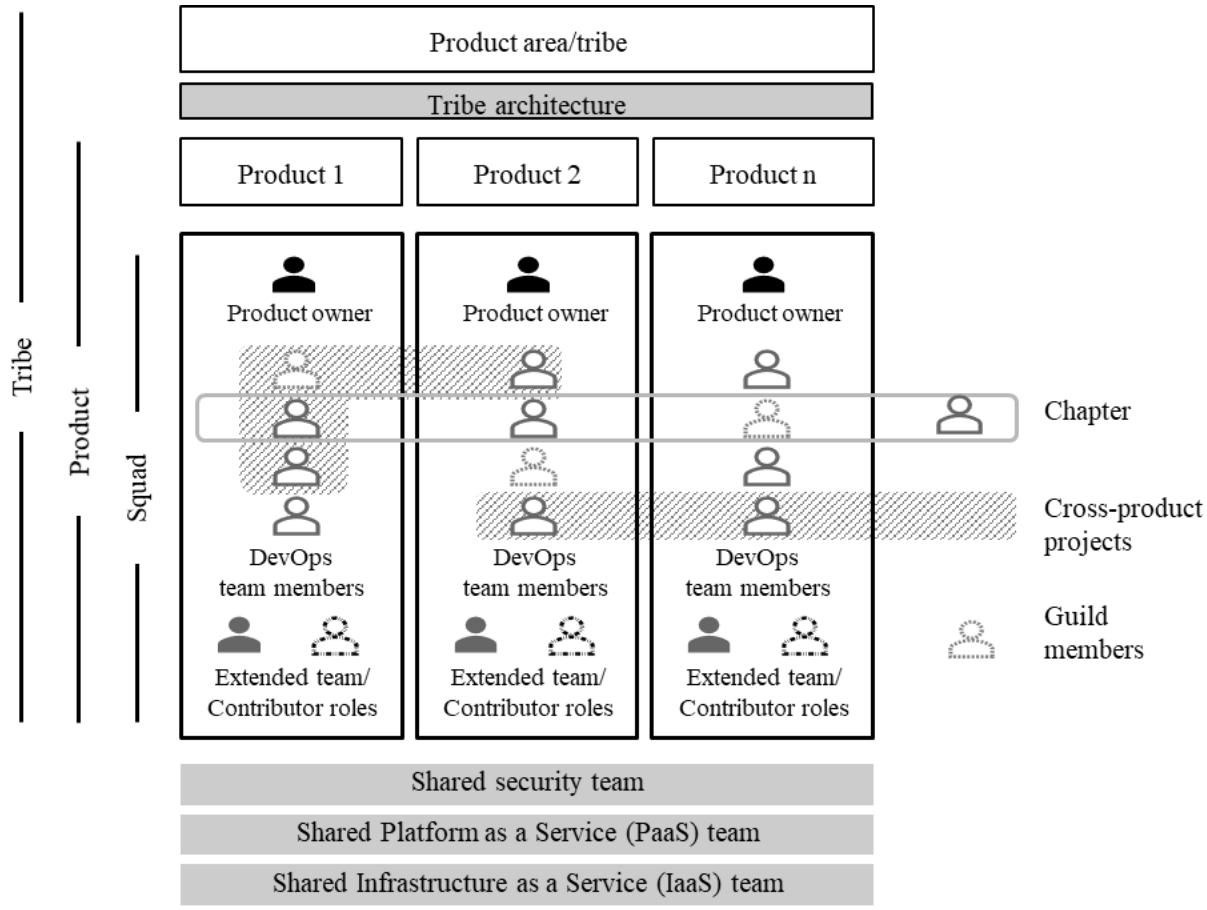

Figure 23. Fully agile unit (model 3 – additionally with cross-product projects)

The question of how to handle projects in a fully agile setting was subject to consideration at CarCo-IT and ChemCo during our research. We understand a project as a temporary organization being unique, novel and transient (Turner & Müller, 2003). In this sense, a project has a defined objective, a start- and end-date and is managed centrally by a dedicated project manager involving resources from various units. In a non-agile organization, projects play a key role for innovation and are comparatively easily handled: All involved units contribute with project resources dedicated to the project with a specific proportion of their working time. By this, projects are – unlike to startups or "born digital" companies especially inherent to established enterprises. Likewise, we have seen model 3 only at established enterprises like CarCo-IT, ChemCo, and ReinsureCo that were used to foster innovation with projects. Consequently, these companies initially tried to integrate projects also in fully agile forms of organizational design.

We observed conflicts between products and projects at model 3 that were similar to governance issues at matrix organizations where a unit has both, a disciplinary (e.g.

industry or region), and functional reporting line. Matrix organizations usually resolve reporting line conflicts by defining a solid and a dotted reporting line clearly indicating which reporting line is leading. These conflicts are hard to be resolved within an agile organization if the project manager's priorities conflict with priorities of the product owner.

Both, CarCo-IT and ChemCo tried to handle resources prioritization conflicts between products and projects by assigning dedicated squad capacities to projects and treated projects like backlog items. This approach worked comparatively well if project resources demand was reasonably stable and required little adaptation during the project. Frequent changes of project resources demand – as it is not uncommon for projects dealing with innovation and novelty – led to numerous capacity adjustments regarding squad team members involved in projects or to a sprint backlog higher than initially intended. These frequent resource alignments between the project manager and the product owner resulted in slowed down delivery of both, projects and squads. Consequently, CarCo-IT returned to model 2.

To avoid prioritization conflicts between products and projects, we have observed that FinCo, InsureCo, SoftwareCo, and ToolsCo prevented the initiation of projects at all by consequently classifying topics usually addressed with projects as user stories (i.e. functional requirements) or backlog items. We observed another alternative at EnergyCo and ServicesCo where projects were delivered exclusively by external resources according to a fixed price and thus avoiding resource conflicts between projects and squads completely.

Model 4: Fully agile unit in a multiple-partner setting

Model 4 – as outlined in Figure 24 – was at the time of research only in place at CarCo-Drive. It further extends model 2 with multiple-partner delivery and an organizational separation between development and operations function.

This model reflects specifics of CarCo's car engineering unit responsible for the development of an autonomous driving development IT-platform. CarCo, a German original equipment manufacturer in the automotive industry (OEM), took on early initiative in developing own autonomous driving capabilities while simultaneously engaging in strategic partnerships with multiple partners including other OEMs and original equipment suppliers (OES). These partnerships aimed at leveraging broader access to cutting-edge technologies like, for instance, machine learning and high-performance computing for the development of the autonomous driving platform.

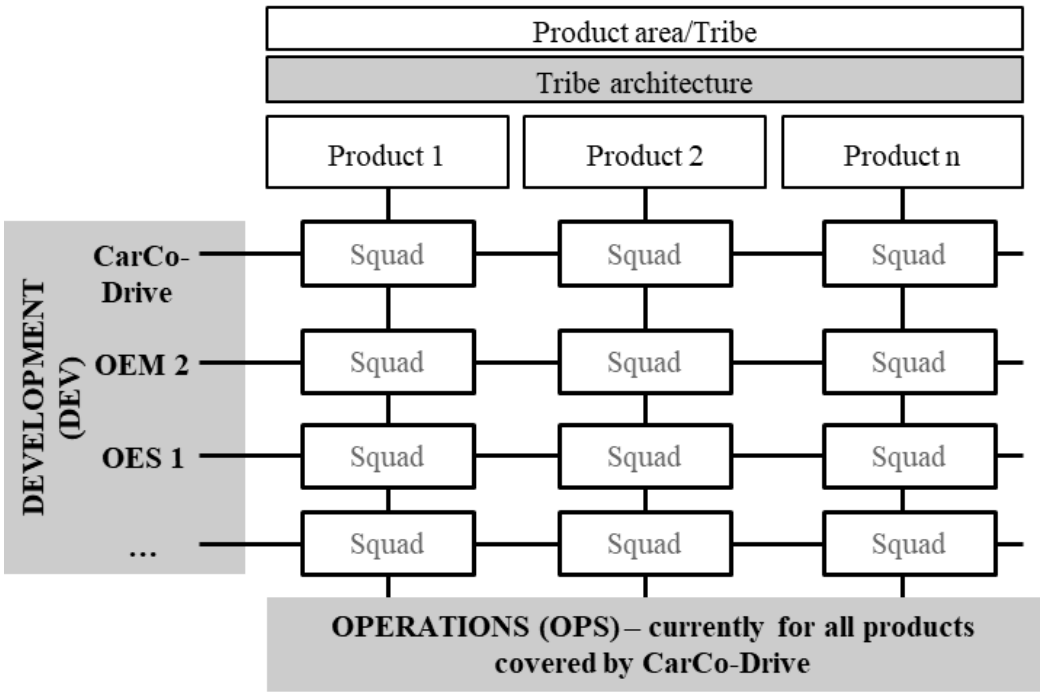

Figure 24. Fully agile unit in multiple-partner setting as applied by CarCo-Drive

Model 4 addresses the challenge of feature co-development for an IT platform: While the IT platform for developing autonomous driving capabilities will be used by several OEMs and OESs, responsibility for development of features is clearly allocated to one OEM or OES and is organized according to the LeSS framework. At the time of our research, responsibility for operations for all features regardless of responsibility for feature development was exclusively with CarCo-Drive reflecting an observation that agile practices are more relevant for development compared to IT operations (Kim et al., 2016; Kulak & Li, 2017). To avoid potential frictions between development and operations as intended in DevOps, IT operations resources from CarCo-Drive partly joined the development squads to ensure mutual knowledge exchange between the team members.

Model 4 extends model 2 as a fully agile unit with a multiple partner setting across companies. Model 4 allows for an additional specialization of involved OEM/OES in feature development according to their core competencies while the clear allocation of operations to CarCo-Drive ensures high standardization and efficient platform operations across feature teams.

Model 4 comes with the shortcoming that the split of responsibility between development and operations in feature teams is prone for conflicts and inefficiencies and, therefore, is in contradiction with the idea of agile ISD in bridging the gap between

software development and operations (Fowler & Highsmith, 2001). Despite of being part of the squads, CarCo-Drive resources lacked in part a mandatory understanding for features developed by partners. Consequently, CarCo-Drive struggled to realize synergies from operations across-products, a well-known phenomenon from traditional ISD according to the waterfall.

V.4.2 Migration paths towards fully agile organizations

Figure 25 provides an overview of the different models for fully agile forms of organizational design and related migration paths we observed at the case study companies during the time of our research.

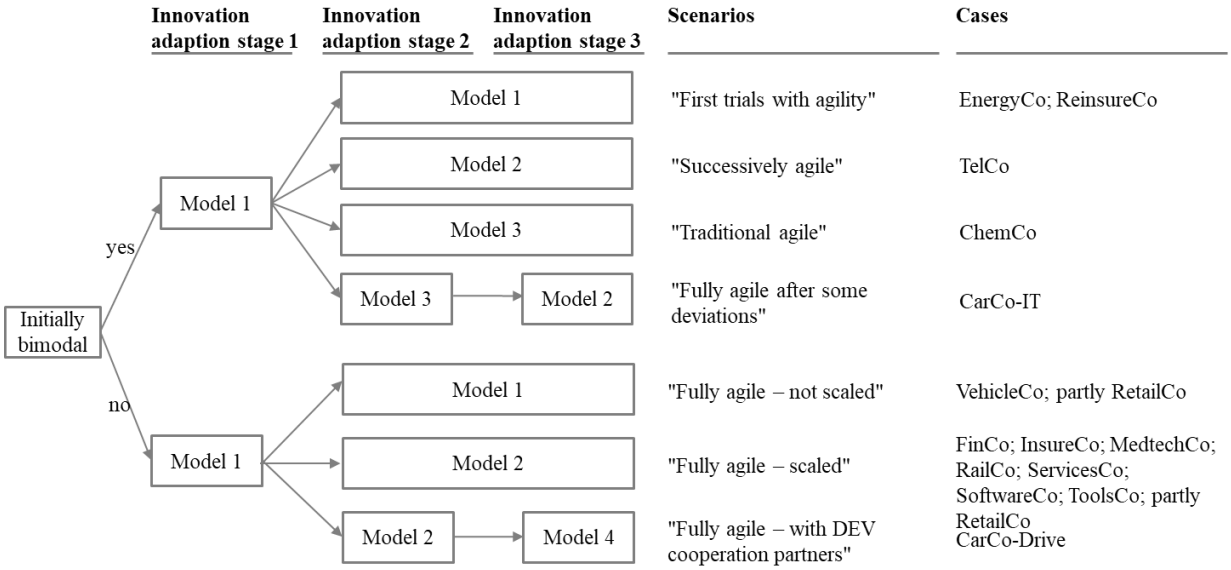

Figure 25. Observed migration paths of agile forms of organizational design at case study

The minority of the case study companies (five out of fifteen case) initially applied a bimodal IT before adopting model 1 as starting point for their agile transformation – an observation contradicting findings of other researchers that a bimodal IT setting is often chosen as initial setting for an agile transformation (Haffke et al., 2017a; Horlach et al., 2017).

We observed in total four different migration scenarios where a bimodal IT setting has been chosen as initial setting for an agile transformation:

1. "First trials with agility": This scenario applies to EnergyCo and ReinsureCo. In this scenario, a bimodal IT setting was the starting point for adopting agile practices and forms of organizational design and this setting remained during the

entire time of our research. An agile unit is separated in this scenario from non-agile units which represent most units within the organization. This setting might work well in cases of separate agile units with limited touchpoints to existing non-agile units (Haffke et al., 2017b; Horlach et al., 2017). EnergyCo represents the IT department of a recently founded spin-off for green energy at a German energy incumbent and ReinsureCo represents the IT department of a reinsure company that has established an internal lab for exploring digital technologies within their IT department. Likewise, ReinsuranceCo established separate agile units as part of a digital lab experimenting largely separated from existing non-agile units.

2. "Successively agile": This scenario applies to TelCo, which initially adopted a bimodal IT setting and decided to replace bimodal IT by a fully agile setting of its IT department. Rationale for this move was that Telco wanted to transform its entire IT department towards a fully agile unit creating thus the necessity to get rid of the initially bimodal IT setting.
3. "Traditional agile": This scenario applies to ChemCo, a major global chemicals company. ChemCo started its agile transformation with an initially bimodal IT setting. After initially positive results, the IT department decided to transform its entire IT department fully agile. But due to the high importance of projects, ChemCo decided to go for a modified fully agile organization reflecting the perceived need to projects. Consequently, ChemCo extended model 2 with cross-product projects, so-called model 3. During the time of our research, ChemCo remained with this scenario.
4. "Fully agile after some deviations": We observed this scenario only at CarCo-IT. Like ChemCo, CarCo-IT adopted model 3 to reflect the importance of projects in their fully agile organization. Contrary to ChemCo, CarCo-IT perceived that the cross-product dimension of projects was heavily interfering with product-orientation of the squads. Unlike ChemCo, CarCo-IT did not find a way to balance diverging interests between products and projects and consequentially adopted model 2.

In addition, we observed three different scenarios for companies immediately adopting fully agile forms of organizational design and not adopting a bimodal IT setting initially:

1. "Fully agile – not scaled": This scenario applies to companies that immediately adopted the Spotify template as a fully agile organization skipping an initially bimodal IT stage. We observed this scenario at VehicleCo and partly at RetailCo.

Both companies belong to cluster IV representing business units that were newly founded. In this case, a new company or new unit has been established and partly grew over time. In both cases, units were still reasonably small enough that no necessity to scale the fully agile setting has been perceived. We however perceive a high likelihood that companies belonging to this scenario will migrate to model 2 as soon as they grow and scale their agile units.

2. "Fully agile – scaled": With a total of eight companies, most of our case study companies adopted this scenario. It represents companies that initially skipped bimodal IT settings and immediately adopted fully agile forms of organizational design. As they grew, they perceived a necessity for cross-squad alignment or potential for synergies. To achieve this, cross-squad teams were established. As most of the case study companies adopted this scenario, it seems to be rather stable and practicable to reflect fully agile scaled forms of organizational design.
3. "Fully agile with DEV cooperation partners". With just CarCo-Drive, this is a specific modification of model 2 reflecting the need to cover significant development efforts in setting with multiple cooperation partners. We have not observed other case study companies to discuss a similar setting. Consequently, CarCo-Drive was the only case study company developing software in a multiple cooperation partner setting.

In the following, we will further specify our findings related to the resulting end models observed during our case study research:

Model 1 remained as resulting fully agile structure in four cases: EnergyCo (IT department; initially bimodal), ReinsureCo (IT department, initially bimodal), VehicleCo (business unit, initially not bimodal), and partly RetailCo (business unit, initially not bimodal). While VehicleCo and partly RetailCo represent rather self-sufficient business units providing business analytics services, EnergyCo represents the IT department of a recently founded spin-off for green energy of a German energy incumbent and ReinsureCo represents the IT department of a reinsure company that has established an internal lab for exploring digital technologies within their IT department. These organizations are of reasonable size with limited alignment need across products or large shared service teams serving several product areas.

With ten out of fifteen cases, most of the case study companies, CarCo-IT, FinCo, InsureCo, MedtechCo, RailCo, ServicesCo, SoftwareCo, TelCo, ToolsCo, and partly RetailCo adopted model 2 as resulting state of a fully agile form of organizational design during our case study research.

Model 3, a fully agile unit with cross-product tribes for architecture and shared services in a joint setting with projects has been adopted by CarCo-IT and ChemCo after adopting model 1. While ChemCo remained at the time of research the only company organized according to model 3, CarCo-IT eliminated projects completely and adopted model 2 in the meantime. Noteworthy, model 3 has only been adopted by cases study companies that were initially bimodal: Startups or "born digital" companies usually immediately turn into fully agile forms of organizational design skipping bimodal settings completely (Tumbas et al., 2017). Contrary, established enterprises like CarCo, ChemCo, or RetailCo – all in business for at least 50 years – came historically from a non-agile environment where projects played and are to some extent still playing an important role for fostering innovation, dealing with novelty, or managing organizational change.

Not surprisingly, companies more inclined to agile practices and structures like SoftwareCo, CarCo-Drive, or new business ventures at RetailCo or VehicleCo adopted fully agile forms of organizational design right from the beginning. These companies eliminated projects completely at an early stage of adopting agile forms of organizational design.

CarCo-Drive, CarCo's autonomous driving business unit is the only case where an organization migrated from model 2 to model 4 taking the specifics of development in a multi-partnering setting into account and reflecting the need for collaboration in a highly innovative and technologically complex environment facing significant shortages of skilled resources.

While most of our cases represent IT organizations, three out of fifteen cases represent business units: CarCo-Drive, VehicleCo, and partly RetailCo. Again, all of them immediately adopted a fully agile structure and skipped bimodal stages confirming findings of other researchers like Horlach et al. that bimodal IT "still mainly implies the transformation of the IT organization and does not focus on transforming the whole organization" (Horlach et al., 2016, p. 5428).

V.5 Discussion

While bimodal IT dominates the extant literature related to agile forms of organizational design in IS research (Haffke et al., 2017a; Horlach et al., 2016; Horlach et al., 2017), our findings reveal that just five out of fifteen case study companies initially applied bimodal IT – CarCo-IT, ChemCo, EnergyCo, ReinsureCo, and TelCo. Our findings are therefore in contrast to extant literature indicating a widespread adoption of bimodal IT

(Haffke et al., 2017a, 2017b; Horlach et al., 2017). All five case study companies have replaced bimodal IT structures by fully agile forms of organizational design during our research. Roemer et al. (2017) confirm this observation in a survey revealing that 63% of the respondents do not trust bimodal IT anymore while 90% perceive cross-functional teams and agile forms of organizational design as superior (Roemer et al., 2017). Contrary to bimodal IT which appeared just recently (Bygstad, 2015), agile forms of organizational design are not new – especially in the IT function (Conboy, 2009; Wang et al., 2012): Industry leaders like FinCo, RetailCo, SoftwareCo or ToolsCo made first steps towards agility almost ten years ago.

Related to fully agile forms of organizational design, we found that model 1 as a generic layout for a fully agile unit remained in just four cases reflecting the need to adapt this model in a scaled agile environment. The most frequently stated reasons for dismissing model 1 were that it works only considerably well in scenarios of limited touchpoints between agile and non-agile units. Furthermore, adopting agile practices and forms of organizational design only in parts of the organization does not increase speed and flexibility in the entire organization (Leffingwell, 2007; Overby et al., 2005; Wendler, 2016). Finally, we observed cultural challenges between agile and non-agile units where non-agile units were perceived partly as legacy and agile units as creative units without operative responsibility for the core business.

FinCo and ToolsCo are especially noteworthy: While applying agile practices and structures is the normal modus operandi for startups or "born digital" companies, established enterprises struggle in adopting agile forms of organizational design (Tumbas et al., 2017). FinCo is an industry pioneer in the financial services industry regarding the adoption of agile forms of organizational design and used digital technologies early for product innovation. Likewise, ToolsCo innovated its business model by applying digital technologies from selling drilling tools to selling drilling as a service resulting in recurring revenue and new service offerings like predictive tools maintenance or automatic supplies replenishment.

Our multiple-case study confirms the findings of other researchers that, as companies innovate on business models and develop new products or services with the help of digital technologies (Weill & Woerner, 2018; Weill & Woerner, 2015), new business units are predestined to be established as fully agile forms of organizational design (Haffke et al., 2017a, 2017b; Horlach et al., 2017). The three cases representing business units, CarCo-Drive, VehicleCo and partly RetailCo, are excellent examples for business units organized according to agile practices and structures as new, digital business

ventures outside IT departments: The global car manufacturer VehicleCo has established an analytics unit as a fully agile structure and RetailCo established a new business venture outside IT. In a similar fashion, CarCo, has established a fully agile unit as part of their car development department to establish a development system for fully autonomous driving of level 4 (fully automated) and level 5 (driverless). As of October 1st, 2017, CarCo has decided to reorganize the autonomous driving unit consisting of more than 900 employees according to the agile framework LeSS and in a fully agile setting creating CarCo's first fully agile unit outside IT. These are exemplary cases where fully agile forms of organizational design have been adopted by business units outside IT.

Furthermore, we found that after initial trials with incorporating projects also in a fully agile setting like at ChemCo or CarCo-IT, companies successively move away from projects as main driver for innovation and adopt a product-oriented structure to increase customer orientation and enable continuous improvement and innovation. Likewise, we have observed model 4, a fully agile unit in a multiple partner setting in just one case (CarCo-Drive) and we do not assume that this model will receive more attention since it in part contradicts underlying agile key principles like overcoming the functional separation between development and operations which this model applies.

All cases have in common that their business model heavily relies on digital technologies. At all case study companies, digital technologies are provided out of fully agile units rather than non-agile or bimodal IT departments. Agile forms of organizational design therefore have clearly left behind the experimental stage only relevant for startups or strategically non-relevant small units (Fitzgerald & Stol, 2017). Consequently, adopting agile practices and structures not only in IT but also in business units is required to increase flexibility and speed of the entire organization (Leffingwell, 2007; Overby et al., 2005). If an organization wishes to be truly agile, its software teams cannot be islands of agile practices and structures – rather the entire organization needs to embrace agility in its processes (Wendler, 2016).

Figure 26 summarizes the results of our multiple-case study.

Model	Description	Cases	Advantages	Disadvantages	Delivery description
1	**Generic fully agile unit**	EnergyCo; ReinsureCo; VehicleCo, partly RetailCo	– Squads have all required resources – Avoids 'functional silos' – Mutual interest to provide deliverables 'end to end'	– Resources limitations, especially regarding specialists – Lack of synergies and standardization	– Squad responsible for one product – PO prioritizes the features – Product development and operations done by the same feature team
2	**Fully agile unit with cross-functional tribe**	CarCo-IT; FinCo; InsureCo; Med-techCo; RailCo ServicesCo; SoftwareCo; TelCo; ToolsCo; partly RetailCo	– Optimized resources allocation due to shared resources – Cross-functional tribe ensuring product/ architecture consistency across products	– Cross-product alignment might slow down product delivery	– Additionally to model 1: – Cross-functional tribe ensures efficient allocation of specialized resources and decides about architecture and tools
3	**Fully agile unit with cross-product projects**	ChemCo	– Reflection of projects in a fully agile setting	– Prioritization conflicts between the product and project	– Squad takes care for delivery of product features – Project covers additional topics
4	**Fully agile unit in a multiple-partner setting**	CarCo-Drive	– Reflection of development in a multiple-partner setting – Split of responsibility between Dev and Ops – Operations synergies realized	– Potential disconnect between Dev and Ops – Increased complexity – Governance challenges with multiple-partners	– Multiple delivery units taking care for product feature development – Ops unit separated from the dev unit allowing the ops unit to specialize on operations exclusively

Figure 26. Summary of case study findings

V.6 Conclusion & Future Work

The question of how to increase speed and flexibility to be as adaptable and resilient while maintaining efficiency and reliability is of strategic importance to almost any company in times of digital transformation (Highsmith, 2013; Ross et al., 2016; Weill & Woerner, 2018). While previous research primarily focused on agile practices and structures as software development method or on bimodal IT (Haffke et al., 2017a, 2017b; Horlach et al., 2017), our research is motivated by the lack of empirical evidence on how established enterprises adopt and scale agile forms of organizational design.

An exploratory study with fifteen global cases has been conducted to gain a deeper understanding of the current state of adopted agile forms of organizational design at established enterprises. We found that companies start their agile transformation by adopting a template for a generic fully agile unit regardless of whether the initial setting was bimodal or not. With increased agile maturity stages, companies enhance this template to their needs by incorporating shared services teams. We found that innovative business units or just recently established new ventures or business units like case study companies in cluster IV were more open towards directly adopting fully agile forms of organizational design and skipping an initial bimodal setting. Our multiple-case study reveals that the adoption of agile forms of organizational design currently takes place at enterprises at large scale regardless of industry or size.

This study builds on extant research related to enterprise agility and bimodal IT and contributes to theory by further extending it to specifically explore the adoption of agile forms of organizational design at established enterprises. We have identified three

models for agile forms of organizational design resulting from the adaptation of a generic template for a fully agile organization, the so-called Spotify model, according to the specific needs and scale of established enterprises. Specifically, we have examined agile forms of organizational design at established enterprises, i.e. no startups or "born digital" companies and aimed at also including business units in context outside information systems development. Furthermore, this study sheds light on how established enterprises adopt agile forms of organizational design over time according their needs and scale and derives seven migration paths. We reveal that agile forms of organizational design are now widespread also at established enterprises and have clearly left the pilot stage of isolated agile islands or digital hubs behind them. Further, by illustrating in detail the migrations paths and agile forms of organizational design which our cases encounter to master the challenges of digital transformation we confirm and extend existing work on digital transformation suggesting that an appropriate organizational form is a critical institutional arrangement to achieve digital innovation (Dremel, Wulf, Herterich, Waizmann, & Brenner, 2017; Hinings, Gegenhuber, & Greenwood, 2018).

Additionally, this study has several practical contributions: We have extended the so called "Spotify-Template" for a fully agile unit (model 1) by three others (model 2-4) taking specific needs of enterprises regarding scale and scope into account. Companies that haven't adopted fully agile forms of organizational design yet could use these models as references for designing agile forms of organizational design. Companies that have already implemented agile forms of organizational design could use the identified models for reflection with their own experience.

Our study does not come without limitations: We have identified fifteen cases to be as representative as possible for established enterprises that have already started adopting agile forms of organizational design. These cases might not be fully representative for companies of all industries or sizes. Furthermore, except for FinCo, RetailCo, SoftwareCo, and ToolsCo, the case study companies were at a comparably early stage of adopting agile forms of organizational design resulting in still ongoing changes regarding organizational setup. Consequently, the presented agile forms of organizational design are snapshots of the current state of agile transformation during time of our research with a high likelihood that adopted agile forms of organizational design will be further modified and enhanced over time. Finally, this multiple-case study relies on the information provided in interviews by a comparatively small number of total respondents (52 interviews in total).

Future work should specifically extend to: (1) understanding how agile forms of organizational design are adopted not only in IT but also in business units that are not engaged in ISD or delivery, (2) understanding the challenges related to organizational culture created during the transformation process from introducing agile forms of organizational design where agile and non-agile units coexist in parallel and (3) understanding how optimization and efficiency could be realized by adopting agile forms of organizational design while simultaneously driving innovation.

Despite the imposed challenges, our research indicates that the adoption of agile forms of organizational design is more than a short-term, transitory trend and will play a significant role as companies need to increase speed and flexibility to innovate with new digital products and services. It remains striking to learn how agile forms of organizational design will be adopted by enterprises in IT and in business units as they move from "doing agile" to "being agile".

VI: Managing Time Complexity with Agility: How More Considered Thinking about Time Helped Fujitsu to Set a Guinness World Record

Title	Managing Time Complexity: How More Considered Thinking about Time Helped Fujitsu to Set a Guinness World Record
Authors	Gerster, D., Dremel, C., Mayer, R. Conboy, K., vom Brocke, J.
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Figure 27. Bibliographic Information for Article VI

Abstract. Digital transformation creates pressure on established enterprises as they need to increase speed and flexibility in order to respond to rapidly changing market environments. To master digital transformation challenges, organizations are increasingly turning to 'high speed' methods such as *flow* and *agile*. We argue that the differentiating feature of these methods is how they address time to achieve speed, epitomized by terms such as *cycle time*, *lead-time*, *latency*, *real-time*, and *velocity*. We examine how Fujitsu succeeded in managing time complexity in its innovation process, setting a Guinness World Record with the largest animated tablet PC mosaic by managing multiple facets of time with the help of selective agile practices. We compare our findings with four other cases confirming that scaled agile practices at their core can help in managing time complexity.

Keywords: Agile practices, agility, digital transformation, temporal complexity, time concepts

VI.1 Introduction

Digital transformation is ubiquitous and companies of virtually all industries and sizes are under pressure to innovate on business models as new competitors create new digital products or services with the help of digital technologies. While startups or born digital companies like Amazon, Facebook or Google are agile by nature, established companies struggle with the question of how to react fast and flexibly to rapidly changing market environments. In consequence, many firms perceive the pace of change in the digital age and the significant increase in resulting challenges[1]. Established companies face a unique set of challenges in increasing speed and flexibility as they need to balance between 'keeping the lights on' with existing operations while at the same time allocating sufficient resources to innovate on new digital services and products. As a response, many companies are currently redesigning their strategy and shaping their digital strategy while at the same time introducing agile practices or structures to increase speed and flexibility.

To succeed in the digital age, companies need to manage time and its inherent time complexity to increase speed and, thus, to reduce time-to-market. The need to increase speed and flexibility to succeed in an increasingly dynamic market environment refers to how we perceive and experience time, our relationship with time and how we interact with time. We borrow from temporal research to examine how established companies manage challenges resulting from time complexity with concepts such as event time and time as cyclical pattern.

The adoption of 'high speed' methods such as agile and flow is perceived as one way to reduce time-to-market and to increase flexibility. Organizational agility has its origins in management research and explains how companies successfully navigate in turbulent environments by sensing environmental change and respond readily[2]. Detecting and seizing market opportunities with speed help firms to continually develop new competitive actions and gain a sustainable competitive advantage[3].

[1] Good references for challenges imposed by digital transformation to traditional companies are (1) Hess, T., Matt, C., Benlian, A., and Wiesböck, F. 2016. "Options for Formulating a Digital Transformation Strategy," *MIS Quarterly Executive* (15:2) and (2) Dixon, J. A., Brohman, K., and Chan, Y. E. 2017. "Dynamic Ambidexterity: Exploiting Exploration for Business Success in the Digital Age," in: Proceedings of the 38th International Conference of Information Systems. Seoul, Korea. Seoul, Korea: AIS.

[2] More on organizational agility can be found in: D'Aveni, R. A., Dagnino, G. B., and Smith, K. G. 2010. "The Age of Temporary Advantage," Strategic Management Journal (31:13), pp. 1371-1385.

[3] The following articles are standard references on organizational agility: (1) Overby, E., Bharadwaj, A., and Sambamurthy, V. 2006. "Enterprise Agility and the Enabling Role of Information Technology," European Journal of Information Systems (15:2), pp. 120-131. (2) Sambamurthy, V., Bharadwaj, A., and Grover, V. 2003. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," MIS Quarterly (27:2), pp. 237-263.

This article examines how agile practices help established companies in managing time complexity and to, thus, increase organizational agility. As there are to our best knowledge few studies analyzing time-related aspects in the context of agility, we describe how Fujitsu set the Guinness World Record for the world's largest animated tablet PC mosaic on November 7, 2017. By applying agile practices, Fujitsu succeeded in managing time complexity and to achieve an ambitious goal under challenging conditions including novelty, technical hurdles, and a short timeline while simultaneously maintaining its budget or quality requirements, process compliance, and relying on resources from non-agile units or service providers. To further enrich our insights, we generalize our lessons learned by comparing the Fujitsu case with four other cases of established companies adopting scaled agile practices to manage specific challenges of time complexity imposed by digital transformation. We conclude with providing managerial recommendations on how time complexity can be addressed by (scaled) agile practices in today's turbulent times.

VI.2 The Complexity of Time

Research and practice often emphasize a traditional, clock view of time, where technology implementation and value is often judged in terms of speed. The challenge is that time is an inherently complex, multi-faceted, subtle concept and is by nature socially embedded – a phenomenon we refer to as time complexity. Time complexity might be assessed as low in case of a lack of time pressure and no foreseeable temporal interdependencies. Scenarios of high complexities, in turn, are characterized in situations of high time pressure imposed by tight deadlines (e.g. delivery of product to customer) in combination with a temporal management style to cope with resulting situation-specific challenges (e.g. consideration of the perception of time under time pressure).

While IS researchers are quick to highlight the impact of information and communication technology on the speed of organizational and social life, they can be slow to address the polymorphous, complex and nuanced nature of time in IS research[4]. This study adopts a framework on time as applied by Ancona, Okhuysen, and Perlow (2001))[5]. This temporal framework provides a comprehensive and holistic analysis of

[4] We recommend the following standard references on temporal theory and time complexity: (1) Nandhakumar, J. 2002. "Managing Time in a Software Factory: Temporal and Spatial Organization of IS Development Activities," The Information Society (18:4), pp. 251-262; (2) Saunders, C., and Kim, J. 2007. "Editor's Comments: Perspectives on Time," MIS Quarterly, pp. iii-xi; (3) Shen, Z., Lyytinen, K., and Yoo, Y. 2014. "Time and Information Technology in Teams: A Review of Empirical Research and Future Research Directions," European Journal of Information Systems (24:5), pp. 492-518.

[5] Ancona, D. G., Okhuysen, G. A., and Perlow, L. A. 2001. "Taking Time to Integrate Temporal Research," *Academy of Management Review* (26:4), pp. 512-529.

temporality, thus synthesizing comprehensive temporal concepts across diverse areas of temporal study and provide a common framework for temporal constructs and variables[6]. Table 10 displays the temporal framework and its different facets including examples according to Ancona et al. (2001).

Category	Subcategory	Sample variables
Conceptions of time	Types of time	Linear time, uniform time, cyclical time, subjective time and event time
	Socially constructed time	Work organization (nine-to-five workdays, work time and family time), celebrations (Passover and/or Easter), time as a renewing cycle and time as linear continuity
Mapping activities to time	Single activity mapping (a)	Scheduling, rate of completion and duration
	Repeated activity mapping (aa)	Cycle, rhythm, frequency and interval
	Single activity transformation mapping (aa')	Life cycles, midpoint transitions, jolts, interrupts and deadline behavior
	Multiple activity mapping (ab)	Relocation of activities, allocation of time, ordering and synchronization
	Comparison and meshing of activity maps (ab) versus (aa)	Entrainment, patterning and temporal symmetry
Actors relating to time	Temporal perception	Experience of time, time passing, time dragging, experience of duration and experience of novelty
	Temporal personality	Temporal orientation and temporal style

Table 10. Classification of temporal categories and subcategories according to Ancona et al. (2001)

This framework places a significant emphasis on the people, social and interpretive issues of temporality. Given that work and particularly agile practices value people over process and aim to empower and unleash creative and social aspects of people and their work, a framework that places such emphasis on these issues is particularly suited to a study such as this.

[6] More on the framework of Ancona et al. (2001) and how it relates with other temporal theories can be found at: Shen, Z., Lyytinen, K., and Yoo, Y. 2015. "Time and Information Technology in Teams: A Review of Empirical Research and Future Research Directions," European Journal of Information Systems (24:5), pp. 492-518.

Time can be experienced in many ways using many types of time or socially constructed time[7]. Typical time concepts that can be differentiated are linear time, clock time, uniform time, event time and cyclical time with the most popular and widely cited time types being 'clock time' and 'event time'[8]. Additionally, mapping activities to time captures the temporal analysis of single activity mapping, repeated activity mapping, single activity transformation mapping, multiple activity mapping as well as comparison and meshing of activities. It explains the commencement, duration and trajectory of the activity. Mapping an activity to time gives organizations awareness of scheduling, rate of completion, duration, cycles, frequencies, interruptions and synchronizations[9]. Actors relating to time explain the way in which each actor uniquely relates to time. Actors may perceive time in a multitude of ways. The perception is based around the continuum of time which flows from the past to the present and future. For example, actors who experience an event for the first time may perceive it to last longer than a seasoned actor in the same position[10]. Furthermore, an actor's relationship to time deeply varies among different cultures, sub-cultures and personalities[11].

VI.3 The Fujitsu Case: Managing Time Complexity to Set a Guinness World Record

Fujitsu is the leading Japanese information and communication technology (ICT) company and supports approximately 140,000 employees, with customers in more than 100 countries[12]. A long-run tradition of Fujitsu's EMEIA region, consisting of the regions Europe, the Middle East, India, and Africa, is to conduct an annual fair for its clients, partners, and prospects. With over 10,000 registered visitors from more than 80 countries, Fujitsu Forum is one of the largest customer events in the ICT industry[13]. Representatives of the Fujitsu EMEIA's top 100 clients were invited to an exclusive dinner reception on the evening before the Fujitsu Forum 2017 started with the idea to create a memorable event in line with the slogan of Fujitsu Forum 2017 – digital co-

[7] Shen, Z., Lyytinen, K., and Yoo, Y. 2015. "Time and Information Technology in Teams: A Review of Empirical Research and Future Research Directions," *European Journal of Information Systems* (24:5), pp. 492-518.

[8] Mosakowski, E., and Earley, P. C. 2000. "A Selective Review of Time Assumptions in Strategy Research," Academy of Management Review (25:4), pp. 796-812.

[9] More on dimensions of world and their underlying aspects of organizational culture can be found at Schriber, J. B., and Gutek, B. A. 1987. "Some Time Dimensions of Work: Measurement of an Underlying Aspect of Organization Culture," Journal of applied psychology (72:4), p. 642.

[10] More on the perception of time can be found at: Ballard, D. I. 2008. "Organizational Temporality over Time: Activity Cycles as Sources of Entrainment," in Time in Organizational Research. Routledge, pp. 226-241.

[11] Mosakowski, E., and Earley, P. C. 2000. "A Selective Review of Time Assumptions in Strategy Research," Academy of Management Review (25:4), pp. 796-812.

[12] More on Fujitsu can be found at Fujitsu's website: http://www.fujitsu.com/global/about/corporate/info/index.html.

[13] The website of the Fujitsu Forum 2017 has all information about the event, its agenda, speakers, presentations, and videos: http://www.fujitsu.com/de/microsite/forum-2017.

creation: To achieve a Guinness World Record with the largest animated tabled computer mosaic where guests would be handed out a tablet PC to afterwards place it in a specific order and to build together a huge screen. What doesn't sound overly complex at first glance turned out to be rather challenging: Tablet PCs are computers and no monitors and need to be modified to display a dedicated part of an animated mosaic or to prevent unwanted notifications on antivirus, firewall, Windows updates or Wi-Fi settings. A minimum of 220 animated tablet PCs had to be used to set the Guinness World Record with the largest animated computer tablet mosaic.

Fujitsu, being an established company and in business since 1935, has highly optimized internal processes in place resulting in challenges inherent to an innovative endeavor like setting a Guinness World Record as it combines technical complexity and novelty with an ambitious timeline. Consequently, it was initially far from obvious of whether Fujitsu would succeed especially when considering the available time of less than three months for the entire project as Fujitsu's Head of Product IT in EMEIA noted:

> *"We have done something new, something disruptive, something completely different. And this is currently a real challenge especially for large, well established companies in IT departments and involved business units" (Fujitsu Head of Product IT in EMEIA).*

VI.3.1 How to Eat an Elephant? The Importance of Time Slicing and Continuous Improvement

An evolving step-by-step approach allowing for failure, incorporating instantaneous feedback and continuous optimization has been applied by Fujitsu to manage time complexity resulting from the ambitious timeline. Figure 28 shows the different project phases. This section briefly describes specific challenges regarding time complexity.

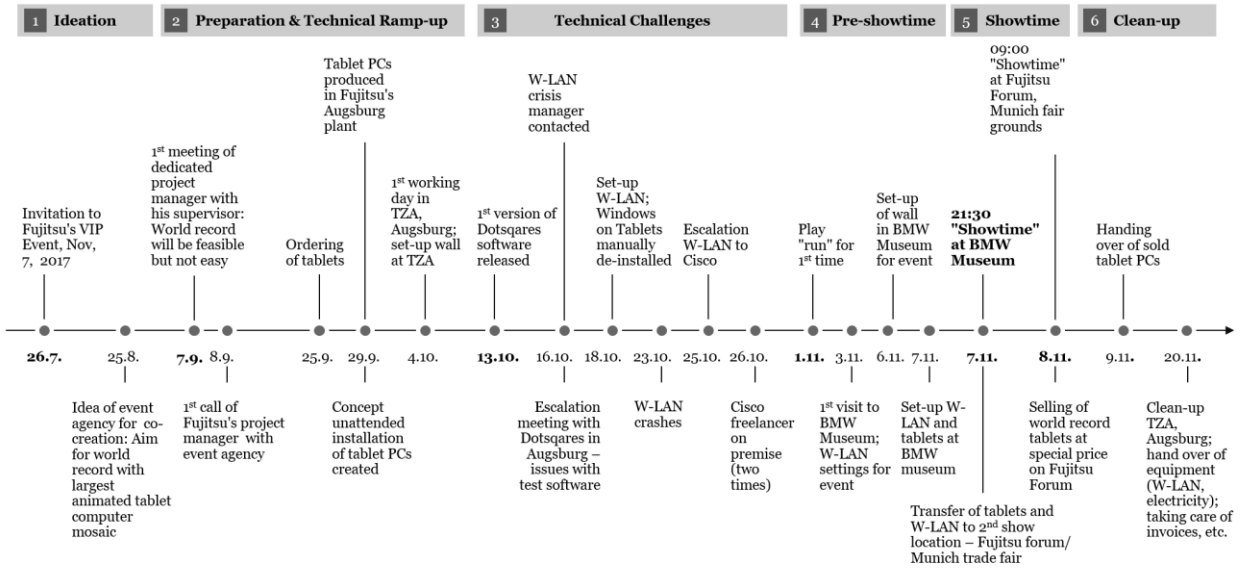

Figure 28. Overview of key project phases and timeline.

Phase 1: Ideation (26.7. - 31.8.2017)

Invitations to Fujitsu's dinner reception guests on November 7 were sent out on July 26, 2017. The idea of achieving a Guinness World Record with the world's largest animated tablet PC mosaic was created by an event agency engaged by Fujitsu to organize the dinner with the initial intent that the event agency assumes full responsibility for the world record attempt. Consequently, Fujitsu did not engage in the preparation of the world record endeavor and was primarily on hold reacting to the event agency's requests.

Phase 2: Preparation and Ramp-up (1.9. - 11.10.2017)

Already during the preparation phase, various challenges and hurdles emerged. The most significant challenges included the question on how to get the required 250 tablet PCs (including spares, development and test devices) manufactured without the usual order lead time as Fujitsu builds to order only, and without causing disturbance to production planning. Further challenges involved the handling of the time lag of signals transferred via Wi-Fi to the tablets and the synchronization of the single tablets to create a fully synchronized display of the mosaic across all tablet PCs. Since the perceived progress was not in line with Fujitsu's expectations at some point in time, Fujitsu decided to assume responsibility for the endeavor with just less than two months remaining. Due to time criticality, Fujitsu decided to appoint a small team including a project manager fully dedicated to the world record attempt endowed with extensive decision rights.

Fujitsu's designated project manager formulated two conditions as prerequisites for his engagement: First, relief of all other duties with 100% time dedicated to the project, and

second, a 'flexible budget' related to the flexibility to circumvent existing and established (non-agile) processes as there would be no time to follow regular processes in place at Fujitsu, related for instance to purchasing or approval policies. Being a hobby lighting designer for concerts, Fujitsu's project manager was fully aware of the concept of 'showtime':

> *"There is a fixed date and time called 'showtime' with a precisely defined starting time until that everything needs to be completed and up running" (Fujitsu Project Manager).*

Right from the beginning the project team was focused on getting everything accomplished until showtime:

> *"It is the spirit that was new to us: We had this 'showtime' and we had not the time to discuss on what could fail. He [the Project Manager] just made announcements what he would need, and we couldn't afford big discussions around that" (Project Team Member).*

The remaining time of this phase was used for planning, preparation and ramp-up of the required components of the world record attempt. Exemplarily, challenges regarding how to handle the time lag of signals transferred via Wi-Fi to the tablets and the synchronization of the single tablets to create a fully synchronized display of the mosaic across all tablet PCs could be sorted out with an Indian software company. Furthermore, a concept for an unattended installation of the tablet PCs with custom settings and the concept for Wi-Fi connectivity has been defined and the electricity supply for charging the tablet PCs simultaneously could be established. Finally, a location for the installation of a so-called training wall for testing the installation of the tablet PC mosaic could be identified nearby to Fujitsu's Augsburg plant.

Phase 3: Technical Realization and Challenges (12.10. - 26.10.2017)

In this phase, Fujitsu focused on the technical realization of the solution: Both, Wi-Fi was up running and an initial version of the software for the video app was available for testing in mid-October. However, unexpected challenges occurred related to Wi-Fi connectivity as the quality was perceived as poor regarding the synchronization of pictures and significant time lags for transmitting signals occurred. One of the three brand-new Wi-Fi routers had been identified as not working properly, i.e. disturbing the signals of the other Wi-Fi routers through providing noise and was consequently replaced with an old and well-tested back-up Wi-Fi router. After this issue was successfully resolved on October 25, the animated mosaic was played for the first time

including all devices revealing further issues with poor synchronization of pictures causing major defects in the correct display of the mosaic that had to be fixed by the software provider.

Phase 4: Pre-Showtime (27.10. - 7.11.2017)

With less than two weeks to showtime, a software update corrected the wrong aspect-ratios of the content allowing the animated tablet PC mosaic to be played correctly for the first time on November 1. This resulted in some time for conducting small software refinements, logistic planning, packing of the tablet PCs and visiting the event location (BMW Museum Munich). The dedicated show wall featuring no power supply and minimum gaps between the tablets PCs was set-up in the BMW Museum on the day of the event.

Phase 5: Showtime (7.11. - 8.11.2017)

As part of the VIP dinner event on November 7, 2017 at BMW Museum, the tablet PCs were handed out to the guests just shortly before showtime and the guests were asked to put the tablet PCs to a designated grid position on the show-wall. A maximum of three attempts for the animated tablet PC mosaic were granted and supervised by participating representatives of the Guinness World Record committee. After all tablet PCs were placed by the event's guests at their dedicated position, an initial connectivity test revealed that all tablet PCs except for three devices had connectivity and responded accordingly. Due to the profound experience in trouble shooting gained earlier in the project related to the challenges with one Wi-Fi router, the problem's root cause was identified quickly: Two tablet PCs were connected erroneously to BMW Museum's free Wi-Fi hotspot and at the third device, the switch for deactivating all connectivity was turned manually into flight mode preventing any connection at all.

After manually correcting the settings at these three devices, the animated tablet PC mosaic was displayed at all 220 tablet PCs as intended in the first attempt resulting in setting the Guinness World Record for the largest animated tablet PC mosaic on November 7, 2017, by Fujitsu[14]. Figure 29 shows the show wall at the BMW Museum on the day when Fujitsu set the Guinness World Record.

[14] An event video documenting the first successful Guinness World Record attempt during the VIP dinner event is available on YouTube: https://www.youtube.com/watch?v=mzrfKUqQgws.

Figure 29. Event location BMW Museum Munich, Germany, on Nov. 7, 2017. The left picture displays the installation of the tablet PC mosaic by Fujitsu's VIP clients and the right picture shows the animated tablet PC mosaic.

Phase 6: Clean-up (8.11. - 20.11.2017)

Due to the focus on bringing the tablet PC mosaic to life, everything else, that could have been postponed like commercial topics, was postponed to a subsequent project phase after the event following the principle of function over processes. On November 20/21, the de-installation of the trainings wall, including location cleaning, took place and rented equipment for electricity and Wi-Fi routers were returned.

VI.3.2 How Managing Different Time Concepts Helped Fujitsu to Set a Guinness World Record

To set the Guinness World Record, managing time complexity related to the deadline of the event – entitled as 'showtime' at Fujitsu – was essential. To appropriately tackle the deadline of the event, Fujitsu applied the concept of time as cyclical pattern: Once the decision was made that Fujitsu takes on responsibility for this endeavor, available time until showtime has been sliced into small time chunks with defined milestones. By de-coupling into small pieces, available time could be used efficiently, and immediate feedback could be incorporated without delays. As in the case of Fujitsu, a challenging task characterized by technical novelty, a short time frame, and uncertainty which needed to be managed simultaneously, requires speed and flexibility – in short agility. Fujitsu exercised full flexibility regarding other parameters of the solution while only applying tools and processes where necessary to be compliant with mandatory corporate rules and processes.

Fujitsu used various measures to successfully manage time complexity. All measures in common is a clear prioritization of key tasks to achieve a deadline through applying a

cyclical pattern for tasks of the activity "World Record" while thoughtfully transforming the activity (e.g. increasing the speed) towards the deadline. The following measures helped Fujitsu to manage time as cyclical pattern:

First, time was treated as an irrefutable deadline, while at the same time Fujitsu remained flexible with solution design to focus on keeping this irrefutable deadline. The ability to remain flexible with solution design while following clearly defined functional requirements is key to manage time complexity resulting from a deadline. Furthermore, a right prioritization of the high number of tasks to be accomplished is essential to avoid resources conflicts.

> *"It is basically like a rock 'n roll stage: There is an irrefutable date, that is showtime. This is a very fixed time to the minute and by then everything has to work" (Project Team Member Fujitsu).*

Second, to manage time complexity imposed by the deadline, Fujitsu's management committed to the project and clearly communicated its priorities within the organization. The clear communication of management priorities was especially helpful to allow the project team to set their priorities accordingly and to by-pass some existing procedures that were not absolutely mandatory to be followed. Additionally, a credible management commitment that failure had no negative consequences was extremely helpful as it gave the team the necessary freedom to find creative and unconventional solutions.

> *"Everybody knew that failure had no negative consequences. People write about successful world records but not about non-successful world record attempts" (Fujitsu Head of Product IT in EMEIA).*

Third, Fujitsu adopted an agile planning approach to optimize available time avoiding spending too much time on advanced planning as no detailed initial planning was feasible due to involved novelty and time complexity. In particular, due to the challenging deadline and the respectively unprojectable task (i.e. the accomplishment of a Guinness World Record), it was obvious that a traditional approach to project planning and management was not appropriate:

> *"I initially tried to draw a Gantt-chart but realized soon that this chart requires more time in drawing than it provided benefits. I only could do one step after the other, as circumstances and priorities changed rapidly. This was truly agile Design-Thinking Mode" (Fujitsu's Project Manager).*

Consequently, it was essential to plan and go from step to step and to adopt the further project course flexibly to the achieved status and unforeseen challenges.

To optimize available time until deadline, Fujitsu purposefully leveraged the slicing of time in form of cyclical patterns to attain the goal of the activity. Fujitsu proceeded in an agile approach applying short cycles of a defined length while having initially only a rough idea of the feasibility: First of all, it was key to have a rough idea about general feasibility and to know the potentially involved components:

> *"I knew that it could work – otherwise I wouldn't have accepted this assignment. I always had to know the involved components and to know of how they could be provided" (Project Manager Fujitsu).*

Detailed specifications of individual features and components of the solution could be developed subsequently in sprints but this initial idea about general feasibility and scope of the solution was important. In addition, Fujitsu de-coupled and incorporated feedback and learnings continuously: Fujitsu had to separate the vision for setting the world record from realization due to several reasons: Despite of the superficially easy task to use tablet PCs as monitors to display an animated computer mosaic, the complexity of the in total involved 13 partners was quite high and novel since Fujitsu had no previous experience related to topics like video animation on tablet PCs.

When executing time-slicing, Fujitsu adopted a 'fail fast and fail early' approach: This fail fast and fail often approach with even provoked failure to explore the limits turned out to be helpful in gaining experience and self-confidence.

To optimize available time in the most efficient way, the realization relied on applying solution components that have already proven to be successful in other instances. Well-established and proven solution components significantly sped up implementation. Fujitsu experienced this related to the Wi-Fi routers where the latest but untested devices had been chosen initially. After causing significant trouble, these brand-new devices had been replaced by tried and tested routers usually used as back-up for events that worked immediately.

Fourth, a small core team consisting of fully dedicated, self-confident and empowered individuals was essential to Fujitsu's success. This approach allowed to keep team-internal alignment and communication to the absolute minimum as no big team needed to be kept in the day-to-day communication loop. A direct and pro-active communication between involved project key personnel has been applied:

> *"Agility is result of immediate action. Therefore, I preferred personal talks to e-mails. For me it was important to choose something based on a profound recommendation" (Project Manager Fujitsu).*

Consequently, the project team was able to focus exclusively on the project outcome rather than on the process. The team members had sufficient self-confidence regarding their subject matter expertise. This self-confidence helped to stay focused on the solution and on figuring out what potentially could go wrong. Furthermore, a 'can do' attitude helped in pragmatically identifying solutions for unforeseen challenges:

> *"Self-confidence is a very important ingredient. Those who don't have self-confidence are the ones finding reasons why it couldn't work. It was the spirit that was new to us: We had this showtime and we had not discussed what could go wrong" (Project Team Member Fujitsu).*

To foster fast decision making, the project manager was provided with comprehensive endowments and the execution of the task "Guinness World Record" included a 4-eyes principle for bypassing corporate standard processes. Consequently, the role of the project manager was comparable to the role of a product owner in agile teams.

Finally, Fujitsu soon realized that they could save valuable time by relying on partners for solution realization compared to an exclusively internal solution development. Solutioning was done in a collaborative partnering approach relying on subject matter experts from Fujitsu's internal and external ecosystem. Given the short timeline and the complexity and diversity of involved technical components, Fujitsu soon realized that an approach focusing exclusively on attaining the goal inhouse would not result in keeping the ambitious deadline. This insight emphasizes the importance of collaboration with a wide network of highly specialized partners while formal aspects of the collaboration could be handled in a pragmatic and unbureaucratic way.

Table 11 summarizes the key concepts applied by Fujitsu to manage time complexity.

Concept	Applied measures
1. Time as deadline ("showtime")	– Focus on the deadline (with a defined minimum functionality)
	– Flexible solution design matched to available overall time
2. Management commitment to priorities	– Clear management commitment to the project and the priorities to shorten implementation time
	– Credible commitment that failure has no consequences to allow full focus on solution design

	– Voluntary participation in challenging endeavors to reduce people management effort
3. Agile and time-sliced approach	– Replace detailed advance-planning and specifications by a step-by-step approach to shorten time spend on project planning
	– Remain flexible and replace comprehensive budget planning by ad-hoc decisions on a needs-basis
	– Time slicing for gradual improvement
	– Fail fast – fail often approach to optimize learnings
	– Rely on tried and tested tools and approaches to shorten implementation duration
4. Team approach	– Small but fully dedicated core team to reduce alignments and communications effort
	– Direct and preferably personal communication (no e-mails, calls, etc.) to speed up communication
5. Collaboration with existing external ecosystem	– Involve specialists from the internal and external network early to reduce implementation duration
	– Agree on a pragmatic working approach avoiding formalism and detailed contracts to speed up the partner sourcing

Table 11. Measures applied by Fujitsu to manage time complexity.

Summarizing the above aspects, Fujitsu fostered the importance of the Guinness World Record through manifesting the irrefutable deadline 'showtime' with management commitment, while drawing on an step-by-step planning approach, a small core team consisting of fully dedicated, self-confident and empowered individuals, paired with Fujitsu's network of experts applying a cyclical pattern for tasks of the activity "World Record" while thoughtfully transforming the activity (e.g. increasing the speed) towards the deadline.

VI.4 How Applying Scaled Agile Practices Help to Manage Time Complexity

This section introduces comparative cases where established companies applied scaled agile practices to address issues of time complexity like increasing speed in customer delivery and reducing cost of delay. While Fujitsu applied agile practices selectively to set a Guinness World Record in a small and fully dedicated team, we compare our

findings with four additional cases of established companies applying scaled agile practices. For all comparative cases the concept of managing time as a cyclical pattern is the common denominator as it plays a central role at agile practices15.

VI.4.1 Managing Time Complexity to Shorten Time-to-Market and Increase Delivery Speed: The Cases of AviationCo and CommunicationCo

Both, AviationCo and CommunicationCo were formerly state-owned European companies and in business for more than 90 years exceeding 30,000 employees (AviationCo), and respectively for 20 years exceeding 210,000 employees (CommunicationCo). Table 12 lists further company details.

	AviationCo	CommunicationCo
Industry	Airline	Telecommunications/ IT services
Age [years]	90+	20+
Employees [#; '000]	30+	210+
Main motivation for adopting scaled agile practices	Eliminate bottlenecks to reduce cost of delay; shorten time-to-market	Reduce the number of unfinished projects; increase delivery speed
Applied scaled agile framework	SAFe	SAFe
Type of unit	Business	Business
Employees in agile unit [#]	Approx. 800	Approx. 12,500

Table 12. Overview comparative cases AviationCo and CommunicationCo as of 31.12.2018.

While both companies already applied agile practices selectively within their IT departments for more than five years, the application of agile practices outside corporate IT in business units took place just recently. Both companies pursued rather similar

[15] According to Dikert et al., scaled agile structures consist of at least 6 feature teams respectively 50 team members where each feature is responsible for a product that is managed by a corresponding product owner: Dikert, K., Paasivaara, M., and Lassenius, C. 2016. "Challenges and Success Factors for Large-Scale Agile Transformations: A Systematic Literature Review," Journal of Systems and Software (119), pp. 87-108. Good summaries and comparisons of the different scaled agile frameworks include: (1) Conboy, K., and Carroll, N. 2019. "Implementing Large-Scale Agile Frameworks: Challenges and Recommendations," IEEE Software (36:2), pp. 44-50 and (2) Kalenda, M., Hyna, P., and Rossi, B. 2018. "Scaling Agile in Large Organizations: Practices, Challenges, and Success Factors," Journal of Software: Evolution and Process (30:10), p. e1954.

objectives for the adoption of scaled agile practices in business units while both have in common to address issues related to time complexity. Namely, reducing time-to-market and increasing delivery speed with the possibility to prioritize features of importance to clients.

AviationCo primarily aimed at finding ways to maximize value generated in cyclical sprints of a defined length of three weeks, to increase organizational speed and flexibility and to reduce the cost of delay in customer delivery. Similarly, CommunicationCo primarily aimed at increasing speed and flexibility but especially at reducing the number of projects that were almost but not completely finished and, thus, preventing delays in customer delivery:

> *"It is like if the boat was still in the harbor because someone was missing, but everybody else was in perfect position and if we would have gone out, we would have rowed perfectly" (Product Owner, CommunicationCo).*

Contrary, AviationCo, as a leading European airline and aviation pioneer in business for more than 90 years, struggled especially with fostering innovation. Exemplarily, as an airline's organization is inclined to reflect hierarchical structures applied in the cockpit consisting of routines, checklists, clearly defined procedures, and chain of command, allowing for a trial-and-error-approach is especially challenging:

> *"We don't want the pilot to test of whether it makes sense to land without the landing gear extended. Consequently, an error culture at an airline is not a question per se, but rather a question of how to establish a learning culture allowing for mistakes where there are no negative consequences" (Director Digital Innovations, AviationCo).*

Both, AviationCo and CommunicationCo chose a unit-wide scope for implementing scaled agile practices with ownership at a dedicated team. The corresponding team size and constitution varied with the organizational scope of the implementation. Each feature team consists of a transformation lead, an agile coach and a scrum master at minimum. AviationCo and CommunicationCo chose a stepwise and iterative implementation approach to address limited feasibility and mitigate potential risks of a big-bang adoption of the scaled agile framework SAFe[16]. Furthermore, both followed a demand-driven approach transforming volunteering teams with no strict implementation timeline.

[16] More on SAFe can be found at: ScaledAgile. 2017. "Essential Safe 4.5." Retrieved 29.10.2017, from http://www.scaledagileframework.com.

AviationCo and CommunicationCo aimed at reflecting the key agile principles: Transparency, continuous improvement, result ownership, and customer centricity by adopting scaled agile practices. Transparency was intended to be achieved by the allocating products to the objectives of the respective unit and by focusing heavily on the interdependencies between feature teams and current challenges, which caused delays in prompt feature delivery. For internal processes or structure, continuous improvement has been achieved with repeating and structured customer-facing and non-customer-facing meetings enabling reflection on success stories and areas for improvement.

Both, AviationCo and CommunicationCo applied a cyclical pattern of repeated activities, i.e. agile sprints to map activities to a fixed period of time. CommunicationCo's objective was to eliminate bottlenecks and to reduce cost of delay. To do so, achieving transparency on current issues resulting in delays was essential. The adoption of scaled agile practices consisting of feature teams with a clearly defined product responsibility and a product backlog with repeated sprint cycles helped them to increase transparency on the delivery status and potential bottlenecks.

Adopting a fully agile organization while following a transparent team structure consisting of feature teams with a homogeneous set of experienced employees with a broad variety of skills helped AviationCo to increase transparency on an organizational level. Agile coaches enabled AviationCo's feature team members to adopt agile routines fostering team alignment and identification and, thus, to increase the output of a feature team within a defined sprint's length. By this, AviationCo found that short sprint cycles were superior to the traditional (non-agile) setting as a defined workload (i.e. the selected backlog items) is approached within a given period of time and in particular with a clear focus:

> *"We realized that a classical project setting was not helpful for what we were doing and that it is much better to proceed in short, interactive cycles" (Agile Coach, AviationCo).*

Contrary, AviationCo also clearly realized that an agile approach is not faster per se and that the traditional approach is sometimes even faster since it requires less time for alignment and communication:

> *"You only get faster feedback allowing to focus on features with value to the customer but the implementation itself does not get faster due to an*

> *increased communication and alignment effort in an agile approach" (Agile Coach, AviationCo).*

Likewise, the primary motivation for CommunicationCo to adopt scaled agile practices were too many projects in the status of "almost" but not completely finished:

> *"The challenge was that we had become too rigid, too inflexible, too slow and too expensive. We have developed too many years on existing systems and have missed the point where tearing down and rebuilding would have been better" (Product Owner, CommunicationCo).*

Agile practices helped CommunicationCo to properly manage time complexity while considering customer feedback early. Putting the focus on customer priorities and results by getting things "almost ready" is no feasible option when taking agile practices seriously.

VI.4.2 Managing Time Complexity to Increase Customer Centricity: The Cases of AutomotiveCo and BankCo

AutomotiveCo and BankCo were stock-listed, private companies right from the beginning. AutomotiveCo is a leading car manufacturer in Germany and in business for more than 100 years exceeding 130,000 employees. BankCo is a European direct bank with a country subsidiary exceeding 4,000 employees and in business for more than 50 years. Table 13 lists further company details.

	AutomotiveCo	BankCo
Industry	Automotive	Financial services
Age [years]	100+	50+
Employees [#; '000]	130+	4+
Main motivation for adopting scaled agile practices	Manage technical innovation in the context of unclear requirements under high time pressure	Increase customer centricity; reduce organizational complexity
Applied scaled agile framework	LeSS	Own framework (best of breed)
Type of unit	Business (car development)	Business (entire company)
Employees in agile unit [#]	Approx. 1,100	Approx. 4,800

Table 13. Overview comparative cases AutomotiveCo and BankCo as of 31.12.2018.

Like AviationCo and CommunicationCo, AutomotiveCo and BankCo adopted scaled agile practices as well. AutomotiveCo chose LeSS[17] whereas BankCo decided not to follow a standard framework for scaled agile but rather adopted an own, internally developed framework integrating best practices from various scaled agile frameworks.

Major implementation objectives differed from AviationCo and CommunicationCo and addressed especially challenging aspects regarding high time complexity: AutomotiveCo and BankCo aimed at increasing customer centricity and organizational innovation capabilities to defend their market position as innovation leaders against tech-companies like Apple or Google becoming increasingly active in the field of autonomous driving or electromobility (in the case of AutomotiveCo) or FinTech's disrupting the financial services industry (BankCo). Consequently, the primary challenge related to time complexity for both companies was to innovate to maintain and defend the competitive edge. AutomotiveCo's car development unit responsible for establishing autonomous driving capabilities had a specific challenge causing high time complexity: Technological novelty (i.e. autonomous driving and machine learning) and hurdles (i.e. analyzing data volumes of up to 200 Petabyte) with frequent changes or unclear regulatory requirements in combination with an ambitious timeline (i.e. start of series production planned for 2021) and a challenging organizational setting involving feature teams provided by cooperation partners of AutomotiveCo consisting of other car manufacturers or suppliers. Consequently, a traditional and iterative approach for feature development would not have worked due to an ambitious timeline (i.e. start of serial production in cars intended for 2021) and unclear and frequently changing requirements related to autonomous driving:

> *"We wouldn't have achieved such an ambitious objective with the traditional approach as we would have lacked speed and flexibility" (Area Product Owner, AutomotiveCo).*

Similar to AutomotiveCo, challenges regarding timing with respect to the market environment were the key motivation to adopt scaled agile practices for BankCo: BankCo as a direct bank was very successful right from the beginning and had a reputation for disrupting established banks. However, BankCo felt the need to react to the increasing competition from FinTechs and to defend its competitive advantage as

[17] A good description of the scaled agile framework LeSS can be found at: Larman, C., and Vodde, B. 2017. "Less.Works." Retrieved 19.4.2018, 2018, from https://less.works/less/framework/index.html.

competitors gained speed. Consequently, the adoption of scaled agile practices was sponsored and supervised by the CEO and targeted the entire bank, as BankCo was convinced that the entire organization has to work agile and not just parts of it:

> *"We as a bank are the elephant that has to keep up with the greyhounds of the FinTechs. FinTechs are fast, modern, innovative and customer-oriented and can realize customer requirements quickly. We have been very successfully for the last years making it difficult for the ordinary employee to understand why we need to change something" (Product Owner, BankCo).*

Consequently, AutomotiveCo and BankCo adopted scaled agile practices organization-wide (BankCo) and department-wide (AutomotiveCo) with the CEO (BankCo) or department-head (AutomotiveCo) being the sponsor for the agile transformation. Implementation took place at both companies with a time-boxed approach in waves with a total duration between 9 months (AutomotiveCo) and 18 months (BankCo).

Related to agile practices, AutomotiveCo and BankCo aimed at creating transparency on the contribution of single tasks and dependencies between squads, feature teams or tribes. Continuous improvement aimed at the product, process, or organizational level. Regarding the organizational structure, focus was on multi-team, structure introducing a matrix structure with product-orientation on the vertical and a professional or technical focus on the horizontal axis. Agile roles were defined on multi-team level first before introduced on team level. For agile routines, focus was on agile routines rather than fostering multi-team alignment. Routines were used for repeating activities like quarterly business reviews for product planning for instance.

All four comparative case study companies applied scaled agile practices with iterative delivery cycles of a defined length (sprints) as time concepts. With this approach of fixed time and effort of feature teams according to sprints, scope respectively value is a deriving result. Contrary, the traditional waterfall model fixes scope of delivery and keeps effort (i.e. quantity and quality of involved resources) and time flexible. The traditional model requires detailed services as basis for time and resources estimation as optimization takes place regarding resources and time. The outcome is the implementation of requirements as defined by business with minimum resources and time.

In contrast, the agile model does not require an initially detailed requirements description as features are specified successively based on the product manager's

prioritization during the sprints. Likewise, the need for innovation requires an incremental approach with the existing feature team size and defined sprint length.

VI.5 Recommendations for Managing Time Complexity

We have derived three key recommendations from comparing the case of Fujitsu's setting of a Guinness World Record for the largest animated tablet PC mosaic with the comparative cases of AutomotiveCo, AviationCo, BankCo, and CommunicationCo. All lessons learned address questions of importance to managers on how to reduce time complexity by adopting scaled agile practices, and, thus, to manage uncertainty in disruptive times of innovation and digital transformation.

We summarize our findings related to our first two recommendations in figure 30 displaying the different evolution approaches regarding the dimensions time complexity and scaled agility.

Our case study findings indicate that the adoption of an agile approach is depending on how companies are addressing selective/ imminent challenges resulting of time complexity (i.e. bottom-up evolution approach) or how companies are addressing foreseeable but business critical challenges to be able to manage time complexity in the near future (e.g. new market entrants in case of AutomotiveCo or shift of market structure due to digital innovation in case of BankCo). Depending on the trigger for adopting an agile approach, companies evolve from quadrant III to II (in case of Fujitsu's world record) and subsequently slowly traversing to I (in case of AviationCo and CommunicationCo) or from quadrant III to IV and subsequently to I (in case of AutomotiveCo and BankCo). While we illustrate these two archetypical evolutionary pathways, we conclude with a recommendation on the key factors determining the success of adopting scaled agile practices.

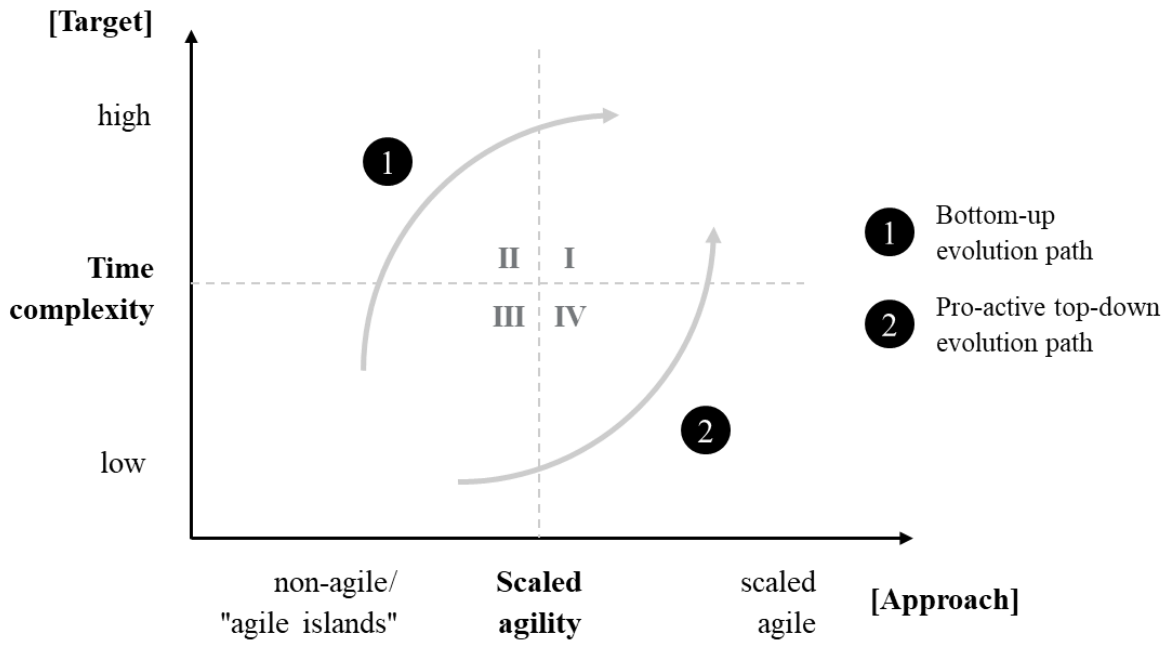

Figure 30. Time complexity vs. scaled agility and related migration paths as observed at the case study companies

1. Use a bottom-up approach for adopting scaled agile practices retro-actively in cases of initial low complexity

The first recommendation relates to the question of how managers should handle situations of low time complexity, i.e. a setting lacking immediate time pressure and without foreseeable temporal interdependencies. In this case, a bottom-up evolution approach for the selective adoption of agile practices turned out to be best-suitable as it combines a high degree of freedom to specific agile teams in transition with the possibility to adopt a scaled agile framework across teams (see figure 30).

In cases of low time complexity as it is the case with AviationCo and CommunicationCo, the focus is on increasing flexibility and delivery speed. Both can be seen as prerequisites for companies to be able to handle more complex time complexity challenges as it is the case with innovation. As we have seen from AviationCo and CommunicationCo, the focus is on increasing speed by reducing the cost of delay (AviationCo) and reducing the number of almost but not completely finished projects (CommunicationCo). In cases of low time complexity, the interdependence across products within an area or across different areas is limited, therefore allowing for a more flexible approach for adopting agile practices. The bottom-up approach has no finite timeline and speed is determined by single units and teams and therefore covers team-specific demands for adopting scaled agile practices. It can

be recommended when an increasing number of units grow organically and adopt scaled agile practices following other units due their positive experience and feedback. Companies adopting a bottom-up approach often start the adoption of scaled agile practices by initiating scrum teams, implementing required multi-team structures where needed, and improving team and multiple-team structures successively with every iteration. Consequently, a bottom-up approach can be recommended when single teams or parts of a unit were in focus for adopting scaled agile practices while the implementation ownership was with the team lead or multi-team leads. In this case, specific needs of individual teams can be addressed. Furthermore, a gradual approach with roll-out in waves allows for the incorporation of lessons-learned from other units that already implemented scaled agile practices.

The bottom-up approach for the adoption of scaled agile practices helped AviationCo and CommunicationCo to identify and eliminate bottlenecks and to, thus, reduce the cost of delay. Introducing cyclical patterns of repeated activities as it is the case in agile sprints with feature teams helped CommunicationCo to identify almost but not completely finished projects and to focus on getting things done within a defined time frame. AviationCo and CommunicationCo have both in common that they adopted scaled agile practices selectively due to a low time complexity to address their specific issues while continuing their bottom-up evolution path to address challenges of high time complexity (e.g. reducing the cost of delay in case of AviationCo and reducing the number of unfinished projects in case of CommunicationCo).

Similarly, Fujitsu adopted agile practices in a non-scaled manner as "agile island" to manage high time complexity imposed by the endeavor to set a Guinness World Record with the largest animated tablet PC mosaic. Fujitsu adopted key principles of agile practices (e.g. focus on function and not processes) to grasp the slight chance of successfully achieving the record. In that endeavor, top management commitment, while planning in relation to sliced time chunks on the foundation of a small core team consisting of fully dedicated, self-confident and empowered individuals in combination with a fully functional and reliable ecosystem of Fujitsu's partners and the application of a cyclical pattern for tasks of the activity "World Record" while thoughtfully transforming the activity (e.g. increasing the speed) towards the deadline.

2. Use a pro-active top-down approach for adopting scaled agile practices top-down in cases of imminent high time complexity

The second recommendation refers to (imminent) situations of high time complexity, i.e. settings of high time pressure where usually a combination of temporal aspects like a temporal management style to cope with situation-specific challenges, tight deadlines, or repeated activities occur. We derive from our comparative cases that a top-down, more tightly managed approach for adopting agile practices should be selected in this case.

In the cases of AutomotiveCo or BankCo, new market entrants and high market pressure (e.g. Fintech companies) or innovations (e.g. autonomous driving) made it necessary to find ways in achieving more speed and flexibility to remain in a leading market position. Despite its innovative nature and technology excellence AutomotiveCo is not untroubled by bureaucratic and inefficient processes which also holds true for BankCo.

Both companies already proved that they were able to handle situations of low time complexity as they already managed to reduce time-to-market, cost of delay, and the number of unfinished projects. Especially BankCo introduced scaled agile practices selectively more than five years ago allowing them to already gain profound expertise with agile practices and to fix challenges related to low time complexity. AutomotiveCo and BankCo aimed at an organization-/ department-wide implementation of scaled agile practices which was sponsored and supervised by either the CEO (BankCo) or the department head (AutomotiveCo) and implementation took place in a top-down approach within a defined, comparably short period of time consisting of several months. This pro-active approach allows for a more structured and more standardized and homogeneous implementation of scaled agile practices as it is the case with the bottom-up approach. By this, the adoption of scaled agile practices helped AutomotiveCo and BankCo to address the significant and imminent challenges imposed by digital transformation and resulting in high time complexity.

Consequently, in cases of imminent high time pressure, a pro-active top-down path with a broader scope of implementation can be recommended where the implementation ownership is with the department head or even CEO. A time-boxed approach with a pre-defined time horizon to conclude the adoption of scaled agile frameworks within a given time is a clear benefit in situations of high time complexity. This approach ensures a closer steering of the implementation with stricter governance and faster – top-down – decision making.

3. Managers need to balance four dimensions to foster agility: People, tasks and routines, technology, as well as processes and structure.

The third recommendation provides actionable advice on how managers can balance four different factors affecting time complexity: People, tasks and routines, technology, and processes and structure. Due to flat hierarchies in agile structures, leadership is especially challenging at agile organizations as usually results are preferred to process or structure[18]. Based on the findings from the Fujitsu case and supported by the comparative cases we identify success factors helping leaders in managing time complexity.

Based on the findings at Fujitsu and the comparative cases we identified four critical dimensions for successfully managing time complexity: People, tasks and routines, technology, and processes and structure.

As observed in the case of Fujitsu, the dimension related to people was critical for setting the Guinness World Record: A small core team consisting of fully dedicated, self-confident and empowered individuals took ownership and coordinated required activities. In particular, Fujitsu's management significantly contributed by trusting the team and not engaging in micro-management or requesting frequent status reports. Furthermore, a credible commitment that failure had no negative consequences was extremely helpful as it gave the team the necessary freedom to find creative and unconventional solutions. The importance of motivating people to become engaged in an agile transformation and to reduce potential fear resulting from the corresponding change process was also underlying in all four comparative cases and was mentioned as an important success factor.

Related to the dimension of tasks and routines, keeping the goal in mind and develop features in waves of continuous improvements focusing on the minimum viable product is important. While it is essential to have a rough idea about feasibility in general and to know the potentially involved components, a detailed planning should be replaced with a cyclical approach according to sprints where improvement takes place in short waves of a defined length. The importance of collaboration with external partners is emphasized while governance and formal aspects of the collaboration should not be limiting factors to the collaboration and should be handled by managers in the background not interfering with day-to-day activities of the team.

[18] For more on essential assumptions of agile practices refer to the Agile Manifesto: Fowler, M., and Highsmith, J. A. 2001. "The Agile Manifesto," Software Development (9:8), pp. 28-35.

Technology and tools play an important role as prerequisites for an efficient and standardized approach – especially in a scaled agile environment. Consequently, feature teams should align on a standardized DevOps toolchain including tools for communication or trouble management to allow for efficient collaboration and status tracking. Especially when agile practices have been adopted recently, managers should provide support with agile coaches facilitating the adoption of agile practices and providing advice on specific questions raised by team members.

Related to the dimension of structure and processes, we revealed from the comparative cases that the adoption of suitable scaled practices according to a framework can help to facilitate standardization and efficiency. Most importantly, structure and processes should be lean and in line with flat hierarchies as it is usually the case with fully agile organizations. The selection of a specific scaled agile framework depends on the company-specific situation. While it is of lower importance which specific scaled agile framework will be selected, companies should take the freedom to adapt existing frameworks to their specific needs as BankCo has done it. Table 14 summarizes the managerial recommendations for reducing time complexity.

Lessons learned	Managerial recommendations
1. Recommendations related to situations of initial low time complexity	
Introducing scaled agile practices bottom-up	– Delegate the lead to teams and allow for team-specific adaptations of agile frameworks.
	– Proceed flexibly regarding the adoption of the time frame to allow for the incorporation of lessons learned from other teams.
	– Give freedom to adopt scale agile frameworks according to the teams' needs.
2. Recommendations related to situations of imminent high time complexity	
Introducing scaled agile practices top-down and pro-actively	– Apply a time-boxed approach for the adoption of scaled agile practices to allow for a timely implementation.
	– Focus on a homogeneous adoption of scaled agile practices.
3. Recommendations related to balancing of four dimensions to foster organizational agility	
a. People	– Empower the team and provide required resources.

	– Delegate authority and responsibility to the lowest level (i.e. the team).
	– Clearly communicate priorities and deadlines without planning for buffers.
	– Allow failure without negative consequences – where feasible.
	– Foster continuous learning and improvement.
b. Tasks and routines	– Focus on outcomes and early results.
	– Proceed in short cycles like sprints of a defined length.
	– Improve gradually in waves with evolving, continually improving results.
	– Co-create with partners and clients for improved results.
	– Involve the client early to improve based on client feedback.
c. Technology and tools	– Provide required tools fostering collaboration and creating transparency.
	– Establish a state-of-the art toolchain supporting continuous testing and feature deployment.
	– Provide instantaneous feedback and coaching to facilitate continuous learning, e.g. by agile coaches.
d. Structure and processes	– Implement lean and agile organizational structures with flat hierarchies.
	– Design processes according to scaled agile frameworks.

Table 14. Managerial recommendations for managing time complexity.

VI.6 Concluding Comments

The question of how to manage time complexity to increase speed and flexibility is essential to virtually any company in times of digital transformation and disruption. While for startups or born digital companies, innovation, speed and flexibility is the main modus operandi, established enterprises struggle with how to respond to uncertainty and rapidly changing market environments in an adequate and timeline way.

This study is motivated by the lack of empirical evidence on how established enterprises manage different aspects of time complexity. Against this backdrop, we examine how Fujitsu, the world's seven-largest IT service provider and being in business since 1935, set the Guinness World Record for the world's largest animated tablet PC mosaic on November 7, 2017. By applying agile practices selectively to manage different time dimensions, Fujitsu succeeded in reducing time complexity despite of an ambitious deadline in combination with technical hurdles, innovation and novelty.

By comparing the findings related to Fujitsu with four established companies applying scaled agile practices to manage time complexity, we reveal that managers (1) should apply a bottom-up approach for adopting scaled agile practices in cases of low time complexity, (2) should apply a pro-active top-down approach for adopting scaled agile practices in case of high time complexity, and (3) need to balance the four dimensions related to people, tasks and routines, technology and tools, and structure and processes by applying different time concepts like time as deadline, time as repeated cycle like in sprints, or time as management style. We believe that these practices will help managers in successfully reducing time complexity imposed by challenges of the digital transformation and disruption.

VI.7 Appendix – Research Approach

The objective of this study was to gain an in-depth understanding of how time complexity can be successfully managed by adopting agile practices. We examined how Fujitsu set the Guinness World Record for the largest animated Tablet PC mosaic by adopting selective agile practices to succeed in a project involving a challenging objective (i.e. a Guinness World Record), technical novelty, and an ambitious timeline and compare these findings with four cases of established companies applying scaled agile frameworks to manage time complexity. Due to the exploratory nature of this study, a qualitative case-study research approach has been chosen[19].

Related to Fujitsu and additionally to the research team, Robert Mayer supported as co-author of this study with access to interview candidates and relevant internal information such as internal reports, photos, videos taken during the project's course, presentations, minutes, etc. To further calibrate the data, we conducted and tape-recorded in-depth interviews with Fujitsu's project manager and Fujitsu team members.

[19] For further details on how to conduct exploratory research with case studies see: Yin, R. K. 2009. *Case Study Research - Design and Methods*. Sage.

Various documentations in the form of pictures, correspondence like e-mails, notes and memos on the occasion of specific incidents were taken to create an extensive dataset as fieldwork journal[20]. The third author, project manager and other team members were interviewed extensively by the first and second author. This was done through open interviews conducted in person[21]. Transcribed and coded interview material with a total duration of 192 minutes, 108 pictures and 9 videos were evaluated in detail. This approach created a rich set of reflections on the project. All interviews were transcribed and analyzed with the computer-aided qualitative data analysis tool Atlas.ti. The data analysis followed a three-stage process of open, axial, and selective coding to get a comprehensive view of Fujitsu's endeavor to set a world record.

For the comparative cases, in total, 13 semi-structured interviews have been conducted lasting from 32 to 60 minutes led in a discovery-oriented way following a semi-structured interview guideline. All interviews were audio-recorded and immediately transcribed to encourage theoretical sampling and the coding procedure, resulting in 130 pages of verbatim transcript.

The coding procedure consisted of open, axial and selective coding[22]. The authors checked the transcripts for completeness and analyzed them separately from one another. Where available, memos or notes were used to capture ideas, further questions or thematic differences. The qualitative data analysis software MaxQDA supported the coding procedure, facilitating comparison of the coding results and memos as well as checking for sufficient inter-coder reliability. Where interpretations between coders diverged, perspectives were discussed iteratively to reach a consensus. This was done to ensure consistency of coding and interpretation.

[20] Further helpful recommendations for qualitative research can be found in: Yin, R. K. 2015. Qualitative Research from Start to Finish. Guilford Publications.

[21] For further details on interviewing techniques in qualitative research refer to Myers, M. D., and Newman, M. 2007. "The Qualitative Interview in IS Research: Examining the Craft," Information and Organization (17:1), pp. 2-26.

[22] For more details on interview coding, see McCracken, G., The long interview, Sage, Canada, 1988.

VII: How Digital Transformation Impacts Sourcing: Learnings from an Autonomous Driving Case

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Abstract. New digital services and products rely heavily on digital technologies and need to be deployed in an ever-shorter timeframe in response to rapidly changing market demands. To address this challenge, more and more companies apply agile practices to increase speed and flexibility. In consequence, companies review their sourcing strategies to shorten tender duration for large-scale IT initiatives and to increase flexibility in contracting of IT services to cope with the anticipated consequences of digital transformation. This study aims at revealing how the application of agile practices impacts the sourcing and contracting of IT services. As the automotive industry is especially affected by the adoption of new digital technologies, this revelatory case study shows how the German premium car manufacturer CarCo increased agility in the sourcing and contracting of IT services for an autonomous driving development IT platform. Agile practices turned out to be essential in dealing with technological novelty and hurdles, regulatory uncertainty, and frequently changing requirements. Applying agile practices to IT sourcing has two major implications: First, agile practices aim at reducing tender duration, decreasing pre-contractual uncertainty, and therefore increasing speed and flexibility. Second, agile software development changes contract nature as comprehensive requirements are replaced by high-level specifications focusing on business outcomes. We contribute to the extant knowledge on IT sourcing and contracting by providing managerial recommendations on how to increase agility in sourcing and contracting of large-scale IT initiatives.

Keywords: IT sourcing, agile sourcing, agile contracts, agile practices, autonomous driving

VII.1 Introduction

New digital services and products rely heavily on digital technologies (Ross et al., 2016; Weill & Woerner, 2015) and need to be deployed in an ever-shorter time in response to rapidly changing market environments (D'Aveni et al., 2010; Overby et al., 2006). In consequence, more and more companies adopt agile practices to increase speed and flexibility (Gerster et al., 2019; Highsmith, 2013). The adoption of agile practices has widespread implications on products, processes, technology, people, and structure that are just beginning to be understood (Gerster et al., 2018). The sourcing and contracting of IT services is especially affected by the need to increase speed and flexibility as unclear or frequently changing requirements due to technical novelty caused by digital technologies are in conflict with well-defined, strict, and long-lasting contracts (Arbogast et al., 2012). Furthermore, the pervasive application of agile information systems development (ISD) significantly impacts IT contracts as comprehensive and well-defined requirements are replaced by lean specifications focusing on business outcomes. This change creates the need to secure capacities for agile feature teams with defined capacities while the exact requirements (i.e. user stories) will be detailed while being implemented. In consequence, companies review their sourcing strategies to reflect agile delivery, reduce tender duration, and to increase speed and contract flexibility (Demirbas et al., 2018; Gewald & Schäfer, 2017).

Against this backdrop, this study takes the sourcing and contracting of IT services as an example for a domain being especially affected by digital transformation. Extant research on sourcing and contracting of IT services deals primarily with large IT projects in a non-agile context (Gewald & Schäfer, 2017), focuses on aspects of IT delivery or governance related to IT outsourcing (Dibbern et al., 2004; Lacity et al., 2009), aims at reducing contractual risks but does not look at project success or missed business opportunities (Arbogast et al., 2012), looks at specific aspects of agile contracting, or lacks practical advice on how the overall tender duration can be reduced (Pries-Heje & Pries-Heje, 2014).

Contrary, this study is motivated by the lack of knowledge and practical advice on how to increase agility in the sourcing and contracting of IT services in the context of large-scale IT initiatives and aims at addressing the research gap related to the need to extend the applicability of agile practices beyond ISD (Conboy, 2009). We aim at generating insights into how agility could be increased in sourcing and contracting of large-scale IT initiatives – in our case an IT platform for the development of autonomous driving capabilities – with the following research question:

How can agility be increased in sourcing and contracting of large-scale IT initiatives?

To do so, we target the automotive industry as it is highly affected by technological innovations such as autonomous driving, connectivity, electromobility, and shared mobility – four trends most easily remembered by the acronym ACES (Heineke & Kampshoff, 2019; Mohr, 2019). Our case study with CarCo, a German Premium car manufacturer, includes technological novelty (i.e. autonomous driving or machine learning) and technical hurdles (i.e. providing storage and computing capacities to analyze data volumes of up to 200 Petabyte) with frequently changing functional requirements or unclear regulatory requirements in target markets in combination with an ambitious timeline (i.e. begin of series production intended for 2021). With our exploratory research endeavor we aim at illuminating the far-reaching implications of adopting new digital technologies in context of an organization applying scaled agile practices and structures according to the framework LeSS (Larman & Vodde, 2017).

VII.2 Background

This section introduces the extant literature related to IT sourcing and contracting in an agile context. We address the disconnect between agile ISD and vendor management and examine how agile practices address issues of traditional ISD. Finally, we examine the impact of agile ISD on IT contracts and how the application of agile practices to IT tenders could help in reducing overall tender duration, pre-contractual uncertainty and, thus, related contractual risks, while simultaneously increasing flexibility.

VII.2.1 The disconnect between agile ISD and vendor management

Agile practices can be seen as a response to challenges resulting from the traditional way of ISD according to "Plan-Build-Run" (Royce, 1987) and the resulting separation between build and run (Rigby et al., 2016). Agile practices root in systems thinking and lean practices (Kulak & Li, 2017; Larman & Vodde, 2017; Leffingwell, 2007) where systems thinking aims at changing our perspective to solve problems in new and unexpected ways (Deming, 2000). The Agile Manifesto is perceived as a practitioners' collection of best practices on agile ISD (Fowler & Highsmith, 2001). Agile practices can be exemplarily characterized by the formulation of value stories, removing complexity, shortening release cycles to incorporate customer feedback, and effort estimation with story points (Conboy, 2009; Rigby et al., 2016; X. Wang et al., 2012). Agile practices aim, for instance, at clean code, pair programming and immediate customer feedback, test-driven development, automated testing, continuous deployment

(B. Fitzgerald & Stol, 2017) and achieve their benefits through the synergistic combination of individual agile practices (B. Fitzgerald et al., 2006).

For reasons of focus we do not include details on the composition of agile teams or their daily practices in this study but refer to the wide body of extant knowledge on agile ISD. For instance, Kniberg (2012) and Gonçalves and Lopes (2014) expalin the setup of agile teams with the case of Spotify. Recker (2017), Przybilla (2018), or Wang (2012) present various insights into daily practices of agile teams like stand-ups, planning poker to estimate development efforts with function points, or retrospectives. Related to project management practices, McAvoy and Butler (2009) highlight the changing role of the project manager in agile ISD as a devil's advocate where teams are empowered to decision making.

The rich literature on IT sourcing is closely related to IT outsourcing which can be defined as "handing over the management of a function, assets, people, or activity to a third party for a specified cost, time and level of service" (L Willcocks et al., 2015, p. 3). In consequence, IT outsourcing can be regarded as a specific form of IT sourcing. Topics of managing risks in IT contracts or governance and vendor management take a prominent take in the extant IT outsourcing literature (Lacity et al., 2009; Liang et al., 2016). Consequently, questions of how to reduce risks and uncertainty in the relationship between client and IT-provider e.g. by a restrictive control with service level agreements (SLAs) or a strict provider governance play an important role from an IT outsourcing perspective (Wu et al., 2015).

While IT outsourcing was in the past largely motivated by process optimization and cost efficiency (Lacity et al., 2009), its focus has shifted towards innovation while offshoring activities have declined in importance (Gewald & Schäfer, 2017). The digitalization of business processes, cloud computing, and cyber-security will have a similar disruptive potential in the upcoming years (Demirbas et al., 2018; IDG, 2017). Consequently, companies are motivated to review their sourcing strategies to reflect the anticipated implications of digital transformation and to increase agility in IT sourcing (Demirbas et al., 2018).

VII.2.2 Incomplete contracts

Incomplete contracts are argued to explain various economic issues (Tirole, 1999). Incomplete contracts are usually preceded by an invocation of transaction costs and one or several of the following three ingredients: Unforeseen contingencies, cost of writing contracts, or cost of enforcing contracts (Tirole, 1999). Key ideas of the incomplete

contracts literature are that contracts are incomplete by nature (Hart & Moore, 1988, 1999) and result from information asymmetries between seller and buyer and, thus, explain for a suboptimal level of sourcing (Tirole, 1999).

Since it is not feasible to include all contingencies into contracts, information asymmetries between buyer and seller result (Hart & Moore, 1988). Consequently, contracts need to find a way to handle uncertainty by assuring cost-efficiency and contract reliability. Agile contracts are perceived as one way to address contract uncertainties and to increase manageability as they aim at an early incorporation of the IT service provider into the solution design allowing for joint-learning and application of best practices (Arbogast et al., 2012; Opelt et al., 2013).

VII.2.3 How agile practices help addressing issues of traditional ISD

Key issues inherent to traditional ISD are that developing complete functional specifications is usually (1) not economical since a considerable effort is required before implementation starts (Book et al., 2012); (2) not feasible since learnings of first iterations of feature development cannot be incorporated (Kim et al., 2016), and (3) not helpful since the client usually remains unable to express all requirements in sufficient complete and consistent detail up front (Kulak & Li, 2017). Consequently, in situations of frequent changes or unclear requirements, endless re-negotiation of requirements may result when traditional approaches to ISD are applied (Pries-Heje & Pries-Heje, 2014).

Contrary, agile practices can help to address some key issues of traditional ISD: (1) Focus on business priorities: Sprints are planned according to business priorities as specified by the product owner as a representative for the client's priorities (X. Wang et al., 2012). This ensures that only features of value to the customer are developed, thus, allowing for a clear prioritization of business objectives and customer value. (2) Focus on workable solutions: Agile practices aim at an early provisioning of prototypes to be used for early client discussions and, thus, allowing for an early incorporation of customer feedback for further improvements in subsequent iterations. (3) Simple design: The recognized lack of helpfulness of complete up-front specification of functional requirements has led to the rise of agile ISD methods such as Scrum (Schwaber & Beedle, 2002) where voluminous specifications are replaced by lean specifications (Book et al., 2012). (4) Small releases are deployed in short, iterative sprint cycles: By this approach, simple functionality is deployed quickly in sprint cycles of two to three weeks (Hekkala et al., 2017; X. Wang et al., 2012). Short sprint cycles ensure that new features can be deployed early, shipped iteratively, and improved gradually (Austin &

Devin, 2009). Furthermore, changing requirements can be taken into account within a reasonably short timeframe (Ågerfalk et al., 2009). (5) Continuous testing and integration: New features will be tested and deployed instantaneously without waiting for big release bundles (B. Fitzgerald & Stol, 2017). (6) Pair programming: Pair programming ensures a quality check already during coding as one developer codes while another programmer checks quality simultaneously (B. Fitzgerald & Stol, 2017). (7) Self-organizing teams: Distributed leadership and decision making speed up implementation and ensure that required information is readily available (Hekkala et al., 2017). (8) Complementing agile management practices: Daily stand-ups and retrospectives serve as supporting organizational culture as they facilitate team communication on sprint status and foster learning and continuous improvement (Hekkala et al., 2017; Recker et al., 2017).

Applying these agile practices to ISD has three significant implications: First, time-to-market for important features can be reduced as features with high business impact can be prioritized by the product owner (Ågerfalk et al., 2009). Second, product quality can be increased due to early and automated testing, incorporated quality checks due to pair programming, communication and mutual feedback (B. Fitzgerald & Stol, 2017). Third, flexibility for deployment of changing features can be increased due to short, iterative sprint cycles and lean requirements specification (Coram & Bohner, 2005). Furthermore, applying short and iterative sprint cycles allows for short term changes of features to be covered in sprints as specification takes place instantaneously with development by the feature team.

An agile and iterative approach to ISD can therefore – by design – decrease risk and uncertainty and can protect clients from things they may not know (Arbogast et al., 2012). Furthermore, an agile approach limits both the scope of the deliverable and extent of the payment and allows for inevitable change, and focuses negotiations on the neglected area of delivery (Arbogast et al., 2012).

VII.2.4 The impact of agile practices on IT contracts

Incorporating agile practices into IT contracts significantly impacts both, fixed price and time and material (T&M) contracts as large and precisely specified contract volumes will be replaced by modules sourced in small and iterative packages (Opelt et al., 2013). Consequently, specific challenges occur for both, fixed price and T&M contracts: Related to fixed-price contracts, challenges exist regarding contract negotiation caused by lean requirements specifications: The overall project scope is defined only high level

causing difficulties in finding an agreement of whether the requirements are fulfilled or not (Opelt et al., 2013). Furthermore, project scope and solutions materialize only gradually and prototyping implies performing a considerable amount of work that does not make it into the final project (Book et al., 2012) making it difficult to reach a fixed-price agreement in an agile setting (Opelt et al., 2013).

Similarly, T&M contracts face challenges regarding agile practices reflected in contracts as well: While T&M contracts seem fairer at first sight as the payment corresponds exactly to the delivered work, they incentivize the provider to increase the development effort and neglect quality control (Book et al., 2012). As a result, implementation risks are almost fully with the client (Pries-Heje & Pries-Heje, 2014).

To summarize, closing contracts is a challenging undertaking especially in the context of technological novelty and uncertainty like ISD and digital technologies (Opelt et al., 2013). Most importantly, successful contracts result from relationships that rely on trust, collaboration, and transparency (Arbogast et al., 2012). Agile contracts acknowledge the fact that all contracts are incomplete by nature, thus setting up mutually agreed-upon frameworks that explicitly address the management of contingencies (Arbogast et al., 2012).

VII.3 Research Approach and Case Study Context

VII.3.1 Research Approach

This study applies an inductive qualitative research approach to explore the need to increase agility in IT sourcing and contracting caused by digital transformation. We conduct a revelatory single case study (Yin, 2009) because of the lack of related extant knowledge and to get rich, in-depth empirical insights. This case study is revelatory for two reasons: First, this case study provides access a phenomenon of interest that has been largely inaccessible to previous research due to topic novelty (i.e. sourcing of a technological innovation enabled by new digital technologies facing unclear or frequently changing requirements). Second, researchers have usually limited exposure to companies applying agile practices (1) at large-scale in an entire department or even the whole organization, or (2) to IT sourcing and contracting as both in combination are still rather new and rare instances. In consequence, we opt for a revelatory case study design to maximize the chances of credible novelty (Langley & Abdallah, 2011).

To obtain in-depth qualitative data, exploratory interviews with managers, experts, and sourcing advisors involved in the tender were used as primary source for data collection.

Interviews were conducted between September 2018 and March 2019 in either English or German based on a semi-structured interview guideline following the recommendations of Schultze and Avital (2011) and Strauss and Corbin (1990) to ground the interviews in the participants' own experiences and to allow the theory to emerge from data. Questions were formulated open-end to allow the interviewees the possibility to explore their experience and views in detail (Strauss & Corbin, 1990; Yin, 2009). Follow-up questions were formulated for further clarification purposes. Each interview had a duration of approximately 50-75 minutes and was carried out personally in face-to-face meetings. The interview results were documented in detail in form of interview notes and, if permitted, in form of recorded interviews. The interviews were reviewed for consistency and completeness by another researcher that has not participated at the interviews. Table 15 provides an overview of the conducted interviews.

Organization/ department	Interviewees	Interviews [#]
Car development (business unit)	Executive sponsor or manager; Team leads; Experts	5
Corporate IT (IT department)	IT-Manager; Experts	4
Purchasing (incl. legal and cost engineering)	Team lead; Sourcing/ cost experts; Sourcing legal advisor	3
Consulting (external sourcing advisors)	Consultants; Project manager	4
IT-provider involved in the tender	Bid manager; Commercial and legal lead	2

Table 15. Overview of case study interviews.

VII.3.2 Case study context: Autonomous driving development system overview and resulting challenges for IT sourcing

This case study examines the challenging task of sourcing and contracting of an IT platform for the development of autonomous driving capabilities at CarCo to examine the implications of applying agile practices to IT sourcing and contracting. CarCo is a leading German premium car manufacturer with more than 130,000 employees and in business for more than 100 years. As an innovation leader and pioneer in electromobility, CarCo decided to bundle its engineering resources to develop autonomous driving capabilities in a centralized unit in 2017 and intended to establish

a centralized IT platform scalable to cover all levels of autonomous driving. CarCo's engineering department responsible for the development of autonomous driving capabilities currently consists of approximately 1,100 full-time employees.

CarCo seeks to develop own autonomous driving capabilities related to high and full autonomous driving (level 4 and 5) according to SAE's definition (Herrmann et al., 2018; SAE, 2018) with intended deployment in serial production in 2021 for level 3. The IT platform for the development of autonomous driving capabilities will be used for programming, simulating and testing of the autonomous driving code to be deployed productively in cars and a central system as of 2021. Figure 32 provides an overview of the business processes required for the development of the autonomous driving code. As the deployed autonomous driving code improves with the amount of driven test kilometers, the collection of real driving data is essential. CarCo currently assumes that two million of driven test kilometers will be sufficient to secure the autonomous driving code for productive usage.

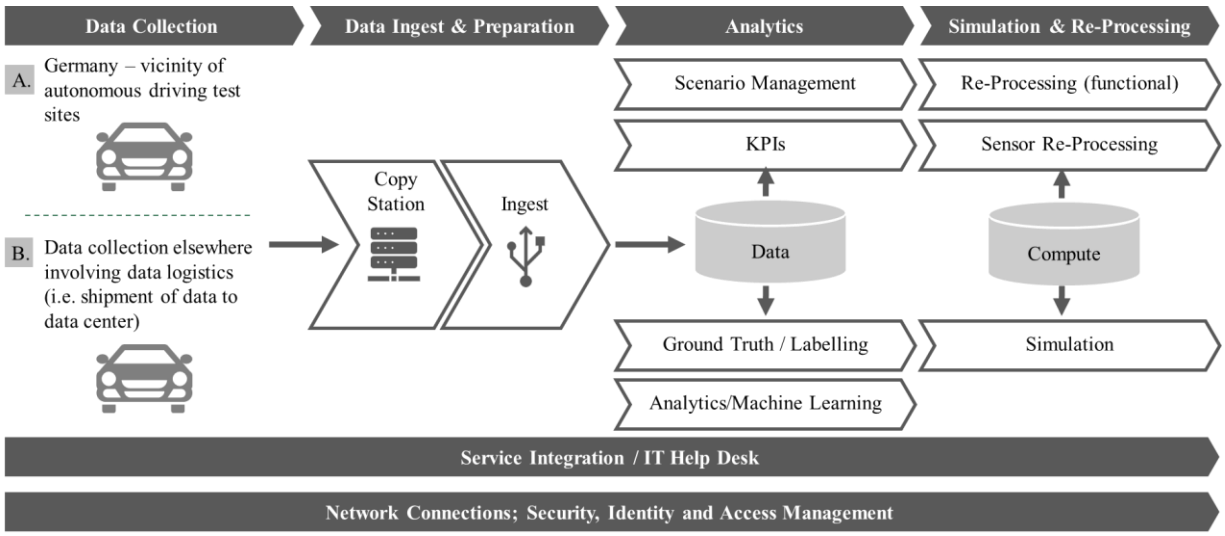

Figure 32. Overview of business value streams and related autonomous driving IT capabilities

Data collection takes place with the help of a test fleet covering a full range of representative driving scenarios in more than 20 countries. Collected data involves camera, lidar, radar and other sensor as well as related driving meta data. Data collected by a test fleet driving in the vicinity of CarCo's autonomous driving development site is directly ingested from the car to the autonomous driving development data center with the help of a copy station. Contrary, data collected during test drives in remote destinations such as other countries are transported physically to the data center

involving a complex physical data logistics (i.e. shipment of disks storing up to 64 TB of data to record the data of the test drives) and directly ingested into the data center. As part of the ingest process, data is checked for completeness and consistency to ensure that the data is of value and can be further processed. Once ingested, data is stored in a centralized data lake where it will be categorized according a predefined set of KPI, and autonomous driving scenarios once automated and manual labelling took place. The data is then used for simulation and training the autonomous driving algorithm (functional re-processing) and for validating new sensor set-ups (sensor re-processing). Services integration and a help desk is provided centrally for the autonomous driving development system along with network connectivity, security, identity and access management.

Contrary to traditional large-scale IT projects, three aspects of this setting are especially noteworthy as they highlight why traditional approaches to IT sourcing and contracting would not be suitable: First, despite of its strong technology focus, the lead for specification, selection, and implementation of the autonomous driving development platform is with CarCo's car development unit and not with its IT department. Resources from CarCo's IT department contributed with subject-matter expertise in an advisory role only. Consequently, resources from CarCo's car development department had neither a profound knowledge and experience in sourcing of large IT projects, nor a decent market knowledge of technology providers being capable of delivering an EUR 200 million IT project, which involves new digital technologies like machine learning, big data, or online video gaming required for simulation purposes. Second, the corresponding car development business unit consists currently of approx. 1,100 employees and is organized entirely according to the scaled agile framework LeSS (Larman & Vodde, 2017). The rationale for this setting was that traditional approaches to ISD were perceived as not suitable to cope with unclear or frequently changing functional requirements resulting from technical novelty or unclear regulatory requirements. Third, CarCo cooperates for the development of autonomous driving capabilities with other car manufacturers and original equipment suppliers (OES) in a joint development setting meaning that each cooperation partner contributes with different feature teams working on the same code basis where area product owners coordinate feature development across feature teams of the different cooperation partners. This setting creates specific challenges as technical compatibility needs to be ensured between cooperation partners (one centralized code basis and code repository)

and as potential cultural differences between cooperation partners from different parts of the world might occur.

In consequence, the following challenges resulted supporting the necessity to deviate from traditional approaches to ISD and particularly for IT sourcing and contracting:

(1) An ambitious timeline as the autonomous driving development platform needed to be available in spring 2019 to secure start of serial production in cars as of 2021. This timeline resulted in roughly one-year lead time between intended go live of the development platform and the initial project start where neither details of the functionality, nor required high-level quantities and platform key parameters were available. Consequently, a traditional approach to ISD would not have been feasible.

(2) Technological novelty as neither CarCo, nor IT-providers had previous experience in establishing an autonomous driving development IT platform of this scale and scope as core platform technology components like machine learning, big data or online video gaming are comparably new digital technologies where IT-providers usually lack a profound experience.

(3) Technical hurdles due to exceptionally high data volumes caused by high and full autonomous driving where an hour of test drive results in approx. 12-15 Terabyte of camera, lidar, radar, other sensor and meta data. Consequently, due to the need to secure proper functionality of new code or code changes, roughly 200 Petabyte of test data need to be stored and reprocessed in case of code or sensor/lidar data changes. To avoid delays in deployment of new code, the platform needs to have a computing capacity allowing the reprocessing of all stored date (i.e. 200 Petabyte) within a sprint's timeframe of two weeks.

(4) Unclear or not fully specified legal framework for operations of autonomous driving systems in the intended markets – Europe, Japan, and the US as policy makers have not yet decided about the local legal minimum requirements for certification of autonomous driving solutions. Consequently, it can be assumed that car manufacturers aim at fulfilling higher standards as legally required to avoid significant changes to their development systems as soon as legal requirements are published by local policy makers.

(5) Unclear or frequently changing requirements due to the novelty of autonomous driving. As already laid out, detailed technical specifications or quantities could not have been specified at the beginning of the project for the establishment of the autonomous driving development system. This circumstance resulted in high uncertainly requiring a

flexibility related to changing system key parameters including technology components or quantities during the project making a traditional "waterfall approach" almost impossible.

(6) Multi-partner setting with other car manufacturers and suppliers engaging in a cooperation for joint development of autonomous driving capabilities. As the automotive industry is faced by four major disruptions known as "ACES" standing for autonomous vehicles, connected cars, electrification, and shared mobility, car makers increasingly cooperate to share investments in new technologies. Like electromobility, autonomous driving involves significant investments (Heineke, Menard, Södergren, & Wrulich, 2019; Mohr, 2019). These new cooperations require new technical infrastructure as for instance code development needs to take place on a joint code base where developers from different car manufacturers need to have access to. Furthermore, the coordination of feature teams across different car manufacturers and suppliers results in organizational complexity and high coordination effort.

VII.4 Results

We observed that agility plays an important role during the tender and related to sourcing as agile ISD services need to be contracted differently from traditional approaches. We refer to agility in the tender as 'agile sourcing' whereas we refer to sourcing of agile ISD services as 'sourcing agile'. The subsequent section presents our case study findings.

VII.4.1 'Agile sourcing' to reduce tender duration and to increase time-to-market

A backwards calculation revealed that the autonomous driving development platform would need to be up running in March 2019 to ensure a seamless start of serial production in 2021. To achieve this ambitious goal, contract signature with the IT-provider establishing the IT platform for the development of autonomous driving capabilities had to take place in November 2018. Consequently, a time frame of roughly nine months for defining the tender scope including volumes, services, functionality, technical concepts, and for vendor selection including contract negotiation resulted. The high-level tender timeline is displayed in Figure 33.

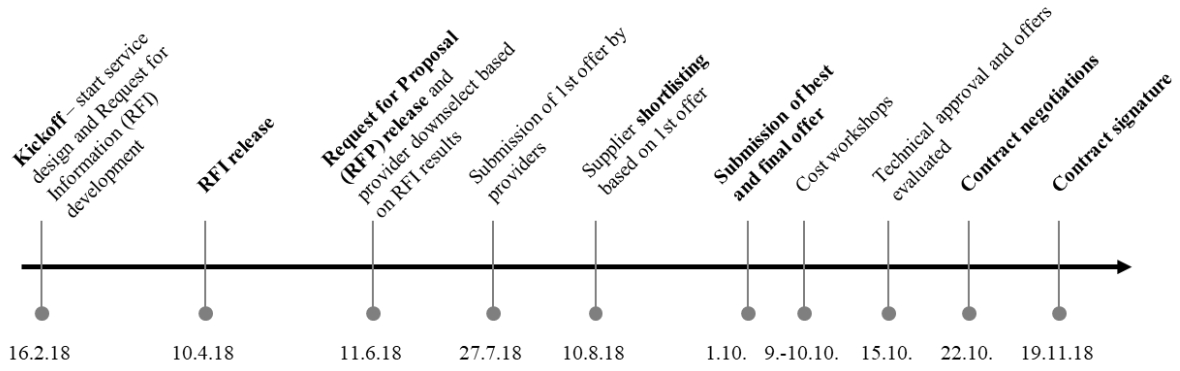

Figure 33. Tender timeline for the IT platform for the development of autonomous driving capabilities.

The following agile practices have been derived from the case study interviews aiming at reducing the tender duration:

(1) Focus on business outcomes ("value stories") exclusively without specifying the means of realization. To achieve this objective, desired business functionalities were defined only high-level as desired outcomes, but details of the realization were left up to the provider. This approach follows the agile practice of focusing on business outcomes and to create freedom for the feature teams to decide about the realization (Fowler & Highsmith, 2001; Kulak & Li, 2017). Consequently, different technologies or means of realization could have been selected by IT-providers based on their expertise or partnerships with other technology cooperation partners in place. This approach significantly differs from traditional ISD using comprehensive statements of work often not only specifying expected deliverables but also related technologies or means for realization of the desired functionalities potentially reducing the degree of freedom for IT-providers significantly. Examples for business services described high-level include the collection of camera, lidar, radar, and sensor data of test drives, the ingestion of collected test data to the centralized platform, or the simulation of the autonomous driving code based on new sensor set-ups. In line with extant knowledge on agile sourcing, the freedom of IT-providers to decide on details of realization can be perceived as lever to shorten tender duration as they are free to apply technologies of their preference (Opelt et al., 2013).

(2) A lean requirements specification describing features only high-level was applied for three reasons: First, to shorten the duration for requirements specification, second, because of the lack of details for specification provisioning due to uncertainty or frequently changing requirements, and third to include providers in the solution design

at an early stage to leverage their ideas and creativity in resolving technical hurdles and challenges. Consequently, only platform key parameters like intended target volumes for the total amount of available storage or computation time for defined operations like reprocessing of a specific data set within a given time were specified. This approach follows the recommendations of the Agile Manifesto that best architecture and requirements designs emerge from self-organizing teams (Fowler & Highsmith, 2001) and reduces overall tender duration (Arbogast et al., 2012).

(3) A service catalogue has been used to describe business services in a structured, standardized and comprehensive way. A service catalogue describes required services in a formal structure and links them with service levels and quantities (Arcilla et al., 2013; Mendes & da Silva, 2010). The service catalogue turned out to be especially beneficial in reducing tender duration: To speed up the process of provider proposal development, IT-providers submitted just a pricing matrix corresponding to the services requested in the services catalogue stating prices along with provider-specific assumptions. To avoid the review of lengthy and provider-specific, non-standardized proposals, only the completed pricing sheet responding to the requested services and the provider's assumption list were subject to contract negotiations. Provider-specific assumptions were then reviewed and discussed between the client and the IT-provider in so called "walk-through-sessions". The documentation of accepted changes in a separate document became part of the contract along with the pricing sheet. This process ensured that the original contract text including all exhibits and attachments remain unchanged and need not to be reviewed for potential changes made by the IT-provider during the tender. Consequently, the resulting negotiations and review of contract documents could be significantly reduced resulting in a reduced tender duration.

(4) As part of the request for proposal (RFP), a detailed discussion between the client and IT-providers on the intended solution took place in workshops. Workshops were organized according to different streams of the tender reflecting key business processes of the development platform for autonomous driving complemented by a commercial and legal stream taking on responsibility for contract negotiation. The approach of detailed discussions between client and IT-providers in workshops ensured that IT-providers could gain a profound understanding of the functionality required by the client and gave the client the possibility to get familiar with the intended technical solution proposed by the provider likewise. This process had three implications: First, IT-providers had the chance to really understand the client's requirements and to get familiar with client key personnel present in the workshops. Second, due to the early

involvement, IT-providers had the chance to make suggestions for specific solutions and, thus, to find superior ways for technical realization related to innovation or novelty. Finally, the teams of the client and IT-providers had the chance to get each other to know in detail allowing for an assessment of potential fit of team cultures for a potential cooperation after contract signature. Consequently, this approach significantly contributed in reducing inherent uncertainty before contract signature resulting in potential conflicts between the client and IT-provider afterwards. In line with an agile approach, solution design made in workshops between the client and the IT-providers was similar to agile sprints for solution design taking place in iterative cycles to immediately incorporating client feedback (Kim et al., 2016).

(5) The tender schedule has been clearly defined and communicated in advance by the client. This approach was necessary to stick to the tight timeline resulting from an intended go-live for the IT platform for the development of autonomous driving capabilities as of 1.3.2019. To do so, the number of workshops in each tender phase was clearly defined and communicated. Consequently, both, the client and IT-providers were forced to bring required stakeholders for decision making on behalf of either party to the workshops due to the lack of the possibility to postpone decisions to subsequent separate meetings. This could have been achieved since IT-providers participating in the tender had to commit in advance to the communicated tender procedure and timeline.

(6) To conduct a profound vendor selection and to increase confidentiality in the future IT-provider, a request for information (RFI) has been initially launched to conduct an IT-provider pre-screening and qualification before entering in an RFP. Despite of consuming almost two months of the time available for the tender, the RFI turned out to be very valuable for the following reasons: First, the ability to address a potentially wider range of providers with the possibility for a vendor pre-qualification before entering the RFP. Second, the possibility to launch the RFI at an earlier point in time as – contrary to the RFP – even not all high-level requirements needed to be defined for the launch of an RFI. Third, to incorporate learnings on smart solutions made by as many as possible IT-providers including highly specified niche-providers with only a limited chance to get qualified in the subsequent RFP. Fourth, to give IT-providers the possibility to understand the client's requirements and tender scope at an earlier stage before entering the RFP enabling them to make more profound assumptions regarding expected tender effort, cost and likelihood for bid winning.

VII.4.2 Contractual agility to increase contract flexibility while maintaining cost-efficiency

Flexibility regarding the contract was highly important while at the same time a fix-price was aimed by the client to achieve cost-reliability. To achieve this contradictious objective, the client applied principles of agile contracting differing significantly from contractual elements used in traditional waterfall contracts.

(1) An 'investment board' approach where only initial quantities for the first quarter after contract signature were specified: This has been done for two reasons: First, a lack of the possibility to specify detailed quantities for subsequent quarters and second, the option to have maximum flexibility regarding the quantities in subsequent quarters in case of changes of demand. To cope with this situation, the client and the IT-provider agreed on a process installing a so-called 'investment board', a monthly meeting of client and provider representatives reviewing system utilization in the previous month and deciding on quantities for the next quarter as well as updating the rolling forecast for quantities in subsequent quarters. To reflect lead times for ordering hardware, the IT-provider had a lead time of three months for establishing agreed capacities. Consequently, all remaining quantities following the first quarter after go-live for the total contract duration of five years would be specified during the course by the 'investment board'.

This approach aims at ensuring maximum flexibility regarding ramp-up of the system's key parameters like computing power or storage. Simultaneously, the provider has enough time to provide requested capacities within enough lead time. To ensure that deployed capacities will not be cancelled by the client before the usual lifetime, the parties agreed that quantity flexibility was limited with respect to two conditions: First, a ramp-down of already deployed capacities would be reimbursed by the client with the anticipated cost for the remaining contract lifetime of the respective component. Second, the ramp-up of capacities would be limited to a maximum of 20% exceeding the already deployed capacity to ensure that the ordered capacity increase can be feasibly deployed without within a quarter's time frame. In case of disputes, an agreed governance with defined escalation mechanisms would apply.

(2) To significantly increase flexibility in contracting of application development services, only a rough indication of the required skills and quantities was given initially provided by the client during the tender: To secure resources availability at the IT-provider, the client committed on initial quantities for application development

according to so-called 'T-shirt sizes'. 'T-shirt sizes' ranked from XS to XL describing an average person day effort for feature development ranging from T-shirt size XS (equaling one-person day) to XL (equaling 21 person days). Furthermore, the client specified the shoring mix for each ordered T-shirt size to allow planning of regional availability of application development resources as requested. Quantities for desired volumes of sprint teams according to a defined T-shirt size and shoring mix were reviewed and adapted by the 'investment board' as well.

(3) Cost-efficiency was intended to be achieved with the following two measures: First, the client aimed at a fixed price agreement despite of flexible scope in a fully agile setting: A fixed price has been agreed based on the scope, quantities, and assumptions made as specified in the pricing sheet. This procedure ensured that the provider had no incentive to increase the scope without receiving additional payment as it is the case in a fixed-price agreement. Only deviations from the quantities stated in the pricing sheet and decided by the 'investment board' were subject to a separate remuneration by the client. Second, cost-efficiency has been achieved by focusing SLAs on business process impact, e.g. interruption of business processes and not the availability of single system components. This approach ensured that only SLAs of relevance for business impact were negotiated and monitored which in turn facilitated a swift contract negotiation of SLAs and a resource-efficient SLA monitoring after go-live.

VII.5 Discussion

We found that agility in IT sourcing and IT contracting can be increased with various agile practices. In all cases, different agile practices applied to IT sourcing and contracting contributed to increasing speed, increasing flexibility, or reducing uncertainty and, thus, reducing contractual risks. Table 16 provides an overview of the different agile practices observed in our case study, the resulting implications (i.e. on how the measures contribute to sourcing, contracting, and operations) and which agility levers apply.

Agile practice	Implications			Agility lever
	Sourcing	Contracting	Operations	
I. Agility in IT sourcing / tender process				
1. Focus on business outcomes ("value stories") without specifying the means of realization.	Tender duration ↓		Time to market ↓	Speed
2. Lean requirements specification with only high-level feature description.	Tender duration ↓	Flexibility ↑	Time to market ↓	Speed; Flexibility
3. Applying a services catalogue for description of business features in a structured and standardized way.		Contractual uncertainty ↓	Time to market ↓	Speed; Risk reduction
4. Engaging in a detailed discussion between client and IT-provider in walk-through sessions as part of the RFP to facilitate a mutual understanding of the solution.		Contractual uncertainty ↓		Risk reduction
5. Communicate the tender schedule clearly in advance.	Tender duration ↓	Contractual uncertainty ↓	Time to market ↓	Speed; risk reduction
6. Conduct an RFI before launching an RFP.		Contractual uncertainty ↓		Risk reduction
II. Contractual agility				
1. Specify only initial quantities and conduct a monthly 'investment board' for utilization review and decision on revised quantities.	Tender duration ↓	Flexibility ↑	Time to market ↓	Speed; Flexibility

2. Contract agile software development with 'T-shirt sizes' for feature teams of a specific size and shoring mix.	Tender duration ↓	Flexibility ↑		Speed; Flexibility
3. Go for an agile fixed-price contract and lean SLAs.	Tender duration ↓	Contractual uncertainty ↓	Time to market ↓	Speed; Risk reduction

Table 16. Overview applied agile practices, implications and resulting agility lever

Related to increasing agility in IT sourcing and contracting, we found that speed can be increased by either reducing tender duration or reducing time to market of critical features. While the reduction of the tender duration by itself increases time to market (i.e. required features are available earlier), some agile practices contribute to the reduction of time to market immediately. Examples are agile practices that reduce the time required for feature specification, development, testing, and deployment as it is the case for instance with a lean requirements specification. This can be achieved by agile ISD in small feature teams that take care of the entire software lifecycle from specification, development, testing, integration, deployment and operations. As feature teams are – unlike project teams – standing, they are already familiar with the topic and can immediately start working productively.

Some agile practices can also contribute to increase flexibility as it is again the case with focus on business outcomes or a lean requirements specification: Both measures reduce the time required for feature specification and focus on specification of features of relevance for clients only. Consequently, a more detailed specification will be done as part of the implementation. By this, the decision on which features to be prioritized can be made at a later point and, thus, increases flexibility related to short-term feature prioritization or taking new features into account on short notice.

Furthermore, agile practices aim at reducing contractual uncertainty: This can be achieved with an early engagement in discussions between the client and IT-provider on feature realization. By this, the IT-provider engages well in advance in discussion of the intended features like which functionality is important to the client, what parameters need to be considered or which technologies and realization alternatives might be available. With this measure, client and IT-provider likewise have the opportunity to get each other to know well in advance before the realization starts and to discuss and align on potentially critical points related to the realization of features.

Related to the resulting IT contract, we found that agility can be increased by the same levers like in the IT sourcing process – increasing speed and flexibility and reducing contractual uncertainty. Tender duration and time to market can be reduced by only specifying initial quantities and defining the quantities for subsequent quarters after contract signature according to a defined process as it is for instance the case with a monthly 'investment board'. Likewise, flexibility in the resulting IT contract can be increased with contracting for external feature teams according to defined 'T-shirt sizes' for teams of a defined skill level, shoring mix and team size. Pre-defined 'T-shirt sizes' ranging from XS to XL avoid lengthy discussions on specifications for IT-provider feature teams. Finally, contractual uncertainty can be reduced by negotiating an agile fixed price contract based on high-level specifications of the required business outcomes. By this approach, the IT-provider has no incentive for spending more time on feature development as it is the case with T&M contracts. Likewise, the client has no commercial risks as the price for a defined set of business outcomes is predefined before development starts.

This study contributes to theory and practice likewise by extending extant knowledge on IT sourcing and contracting with agile practices. Related to theory, we reveal that theory to IT sourcing and contracting needs to be extended regarding two dimensions. First, if the subject matter of sourcing is agile ISD, relevant measures for sourcing agile software development services need to be applied. For instance, comprehensive statements of work should be replaced by high-level functional requirements and development capacities will be sourced according to fixed capacities – feature teams of a defined size according to 'T-shirt sizes', skill- and shoring mix. Second, this study shows how applying agile practices in the tender process can reduce tender duration and can contribute in reducing pre-contractual risks and uncertainty by involving IT-providers early in the tender process and benefit from their experience regarding the solution design.

Related to practice, this study shows how managers in charge for large-scale IT tenders can speed up the tender process by applying agile practices into the sourcing process.

VII.6 Conclusion

Companies increasingly adopt agile practices to foster innovation and performance in rapidly changing market environments (Sambamurthy et al., 2003). While agile practices are widespread at startups or born digital companies like Amazon or Google

(Tumbas et al., 2017a), established companies started to adopt agile practices just recently (Gerster et al., 2018).

This study aims at revealing the implications and potential benefits of applying agile practices to the sourcing and contracting of large-scale IT endeavors. Accordingly, our research is motivated by the lack of empirical evidence on how agility can be increased in the sourcing and contracting of IT services by referring to a revelatory case study with CarCo in the context of autonomous driving. We contribute to the rich body of knowledge on IT sourcing and contracting with examples on how to reduce the duration of large-scale IT tenders and to increase the flexibility at IT contracts. For practitioners, this case study provides insights on how the application of agile practices to the domain of IT sourcing and contracting can help to reduce the duration of large-scale IT tenders and pre-contractual uncertainty while flexibility of the resulting IT contract can be increased.

This study does not come without limitations: This case of CarCo in the context of autonomous driving might not be transferrable to companies of other industries or size classes. Specifically, prestige projects involving technological innovation like in the case of autonomous driving significantly increase chances that an IT-provider engages in new or uncommon contract types and takes on related contractual risks. Furthermore, due to topic novelty, only the time frame related to the sourcing of the platform for development of autonomous driving capabilities could have been considered. A longitudinal study of how the agile principles formulated in the contract would come into live after contract start, for instance related to the monthly 'investment board' for reviewing system utilization and adopting quantities for subsequent quarters, seems to be especially worthwhile.

Our future research will cover the following aspects: First, a longitudinal observation examining how agile contract components work in practice after contract signature seems required to validate of whether the measures for increasing contractual flexibility before contract signature came into effect. Second, due to the focus on the time span before contract signature, aspects of provider management and governance in a fully agile setting have not been considered. As this contract makes use of new contractual elements like a monthly 'investment board' for reviewing and adapting system utilization and deciding on quantity changes in the subsequent quarters, we would expect specific challenges resulting from these new and rather untested agile contract mechanisms. Third, as CarCo starts to establish cooperations with other car manufacturers and suppliers to share investments in autonomous driving development systems, specific

aspects of the cooperation (i.e. how to coordinate feature teams from cooperation partners) should be reflected. Finally, the perspective of IT-providers has not been sufficiently considered in this study. As IT-providers are vital in service delivery, we assume that this important perspective of the other contractual partner cannot be excluded.

Despite of the novelty of the content and the significant challenges imposed by the adoption of agile practices to IT sourcing and contracting, agility seem to be more than a short-term, transitory trend and is likely to play an important role as companies seek to increase speed and flexibility in response to rapidly changing market environments. It remains striking to learn how agility can be increased in sourcing and contracting of large-scale IT projects.

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Part C – Appendix

Appendix A – Complete List of Publications

Publications in chronological order from new to old; official order of authors that indicates the contributions of the authors.

Published and Accepted Journal Articles and Articles in Conference Proceedings

Meta-data of Publication	*Ranking*[23]
Gerster, D., Dremel, C., Brenner, W. and Kelker, P. (2020). "How Enterprises Adopt Agile Forms of Organizational Design: A Multiple-Case Study," in *ACM SIGMIS Database: the DATABASE for Advances in Information Systems,* Volume 51, Issue 1.	WI: B VHB: B
Schuch, F., **Gerster, D.**, Hein, D and Benlian, A. (2020). Implementing Scaled-Agile Frameworks at Non-Digital Born Companies – A Multiple Case Study in *Proceedings of the 53rd Hawaii International Conference on System Sciences*, Maui, Hawaii.	WI: B VHB: C
Gerster, D. and Dremel, C. (2019). "AGILE CONTRACTS: LEARNINGS FROM AN AUTONOMOUS DRIVING SOURCING PROJECT," in *Proceedings of the 27th European Conference on Information Systems*, Stockholm-Uppsala, Sweden.	WI: A VHB: B
Gerster, D., Dremel, C., Brenner, W., and Kelker, P. (2019). "Scaling Agility: How enterprises adopt agile forms of organizational design," in *Proceedings of the 52nd Hawaii International Conference on System Sciences*, Maui, Hawaii.	WI: B VHB: C
Gerster, D., Dremel, C., and Kelker, P. (2018). "Scaling Agility: How enterprises adopt agile forms of organizational design," in *Proceedings of the 28th International Conference on Information Systems*, San Francisco, USA.	WI: A VHB: A
Gerster, D., Dremel, C., and Kelker, P. (2018). "'Agile meets non-agile': Implications of adopting agile practices at enterprises," in	WI: B VHB: D

[23] Ranking according to VHB-JOURQUAL3 (http://vhbonline.org/VHB4you/jourqual/vhb-jourqual-3/gesamtliste/) and 'WI-Orientierungsliste' (http://wi.vhbonline.org/zeitschriftenrankings/)

Proceedings of the 24th American Conference on Information Systems, New Orleans, USA.

Gerster, D. (2017). "Digital Transformation and IT: Current State of Research," in *Proceedings of the 21st Pacific Asia Conference on Information Systems*, Langkawi, Malaysia. WI: B VHB: C

Book Chapters and Contributions

Gerster, D. (2017). "Praxisbeispiel T 11: Ermittlung des Wertbeitrags der Ablösung des Altsystems durch eine ERP-Cloud-Lösung". in Lemke, C., Brenner, W. and Kirchner, K. (2017). *Einführung in die Wirtschaftsinformatik*. Springer Gabler, Berlin, Heidelberg, pp. 349–351. WI: n.a. VHB: n.a.

Unpublished Articles

Gerster, D., Dremel, C., Mayer, R., Conboy, K, and Vom Brocke J. (Revised - Resubmit). "How Agile Practices helped Fujitsu to Set a Guinness World Record," in *MIS Quarterly Executive*. WI: B VHB: B

Gerster, D. and Dremel, C., "How Digital Transformation Impacts Sourcing: Learnings from an Autonomous Driving Case," in *Proceedings of the 14th Global Sourcing Workshop, Springer.* WI: n.a. VHB: n.a.

Appendix B – Curriculum Vitae

Personal Data

Place of Birth	Freiburg, Germany
Nationality	German

Academic Education

2016 - 2020	University of St.Gallen (HSG) – PhD studies in Management, Specialization: Business Innovation at the Institute of Information Management (IWI-HSG); St. Gallen (Switzerland)
1996 - 1998	Rheinische Friedrich-Wilhelms-Universität Bonn – Diploma (Dipl. VW) in Economics; Bonn (Germany)
1995 - 1996	University of Wisconsin, Madison (USA) – Exchange studies with DAAD at the School of Business and Department of Economics; Madison, WI (USA)
1993 - 1995	Albert-Ludwigs-Universität Freiburg – Bachelor (B. SC) in Economics; Freiburg (Germany)
1985 - 1993	Berthold Gymnasium Freiburg – A-Levels; Freiburg (Germany)

Employment

06/2017 – current	Information Services Group Germany (ISG) – Director Digital Strategy & Solutions, Frankfurt (Germany)
08/2008 – 05/2017	Roland Berger Holding GmbH – Principal and Global CIO; Munich (Germany)
09/2007 – 07/2008	Roland Berger Strategy Consultants Holding GmbH – Senior IT-Manager; Munich (Germany)
12/1998 – 08/2007	Roland Berger Strategy Consultants GmbH – Senior Project Manager; Dusseldorf and Munich (Germany)

07/1998 – 10/1998	Procter & Gamble, Schwalbach/Ts. (Germany), Pampers Wipes Europe – Intern; Schwalbach/Ts. (Germany)
07/1997 – 09/1997	Gemini Consulting, Bad Homburg (Germany) – Intern; Bad Homburg (Germany)
02/1995 – 04/1995	Siemens Nixdorf, Augsburg (Germany) – Intern; Augsburg (Germany)
07/1994 – 09/1994	Badische Zeitung Freiburg (Germany) – Intern; Freiburg (Germany)