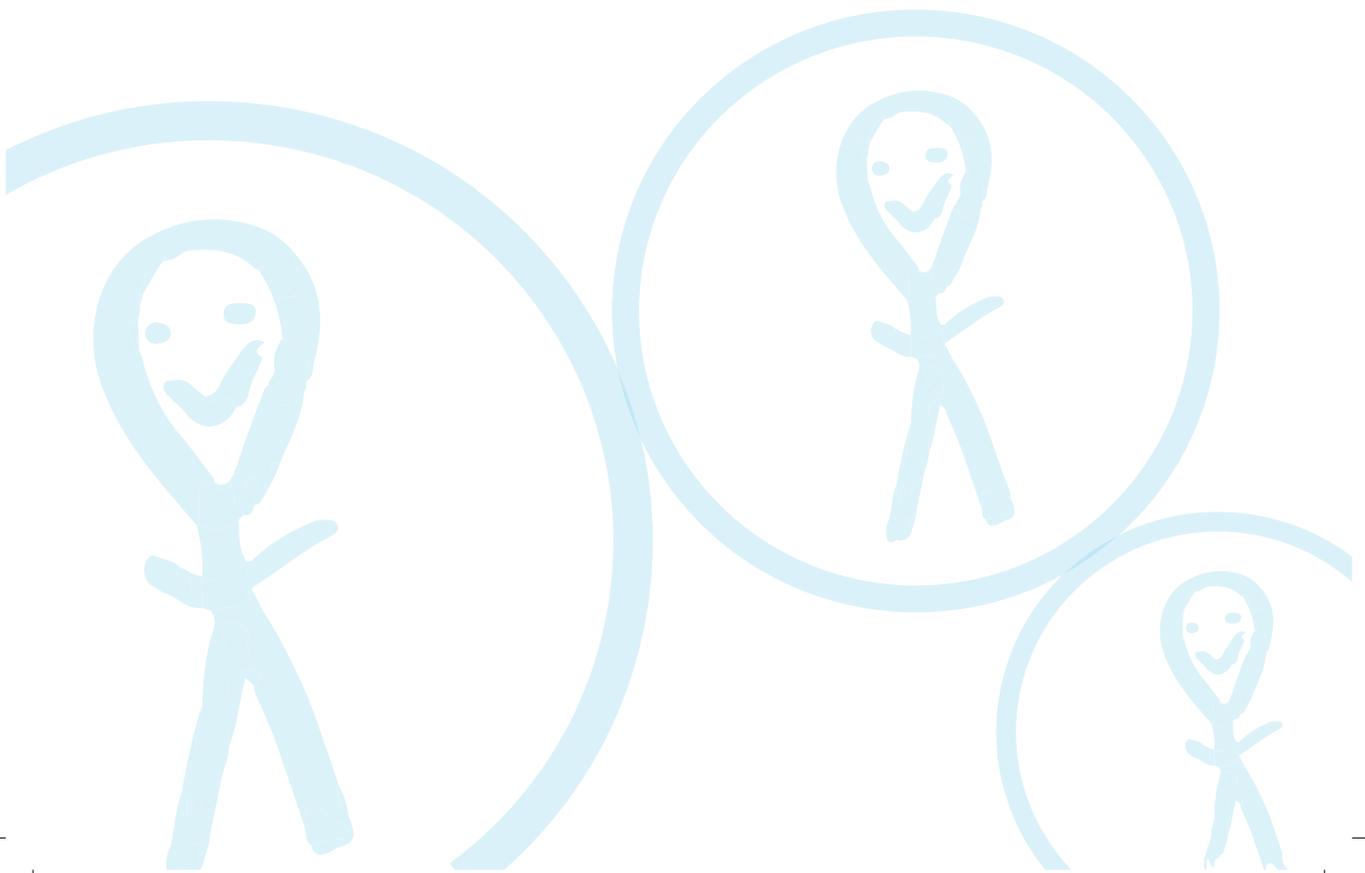


Chapter 1

Introduction



The Industrial Revolution transitioned manufacturing processes from hand production methods to machines. To achieve that transition, work was split into discrete unambiguous tasks (Taylor, 1914). These discrete tasks allowed a controlled execution by machines and low educated staff (Taylor, 1914). To organize the work, the machines and staff were grouped into departments, each with predefined responsibilities, placed in a hierarchical structure (Mintzberg, 1989). Since each staff member was responsible for one or more discrete tasks they lost sight over the overall workflow process and were unable to organize the work themselves. The organization of the work was therefore done by separate supporting staff and the techno structure (Mintzberg, 1989). Nowadays many large companies still hierarchically organize work.

Hierarchical structures are good for reaching top-down decision making among large numbers of people in a timely fashion (J.R Galbraith, 1977). Though, in today's fast moving business, creativity and operational autonomy are important to survive competition (G. Lee & Xia, 2010). To that end staff working in different departments needs to spontaneously collaborate and share information (Beck, 2010). In a traditional hierarchical structure, however, information flows from workers up and down via the chain-of-command, involving many people, obstructing efficient collaboration and information sharing (Cummings & Worley, 2014). Information technology (IT) overcame the dysfunctional effects, by peer-to-peer, low boundary information sharing between staff without involving management (Melville, Kraemer, & Gurbaxani, 2004). That direct point-to-point information sharing allows efficient information sharing and collaboration in workflow processing that cross many departments (Davenport & Short, 2003). Large companies therefore highly depend on IT, for maintaining their competitiveness in today's fast moving business (Melville et al., 2004). The IT that supports these workflow processes consists of many interdependent IT components (Zachman, 2002). These IT components have typically critical interdependencies; only in case all interdependent IT components function correctly, workflow processing is enabled. For instance a financial services App on a mobile device requires many interdependent IT components for executing a payment transaction between two banking accounts.

To keep the IT components operational, human activities from IT staff are required; for instance an IT failure that requires replacement of a physical component by maintenance staff (Kumbakara, 2008). The combination of predefined IT and human activities for delivering IT are defined as IT services (Beck, 2010; van Bon, Jong, & Kolthof, 2007). Based on van Bon et al. (2007) in this dissertation an IT service is defined as: "a mix of predefined automated and human activities, enabled by hardware and software". This definition fits the three service characteristics as opposed to those of physical products (Baltacioglu, Ada, Kaplan, & Yurt, 2007; Moeller, 2010; Niessink & van Vliet, 2000; Parasuraman, Zeithaml, & Berry, 1985, 1988): (1)

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Intangibility, services cannot be seen, touched, smelt or tasted, as they are 'performances' rather than 'things'. (2) Simultaneity; reflecting the fact that users must be present for the service to be provided. (3) Perishability; if a service is not consumed when available, the unused capacity is lost.

IT services are delivered by IT service providers (ISPs) (Kumbakara, 2008). Some ISPs deliver specialized IT services to a single company, such as a finance department. Other ISPs deliver IT services to a worldwide customer base, such as Google Drive. Many ISPs also deliver IT services to other ISPs. For instance Microsoft delivering a cloud based application hosting platform to an internal ISP of a company. Together these ISPs form networks, each delivering interdependent IT services.

IT services in that interdependent network are continuously updated, upgraded and renewed, to adapt to the fast moving economy (Beck, 2010). The faster an IT service network realizes these changes, the better an IT service network can adapt to changes in the business environment. Performing such changes on the IT services is a complex task, as IT services (and the IT components of the IT service) have many interdependencies spanning multiple ISPs. A change therefore typically impacts multiple IT services delivered by different ISPs (Plugge & Janssen, 2009; TFSC, 2011). Given these interdependencies, staff from different IT services staff needs to collaborate between and within ISPs; for instance during impact analysis and testing activities or during IT failure analysis to find the root-cause. With improved collaboration within and between ISPs, IT services can be changed faster (Costa, Cataldo, & de Souza, 2011; Sharp & Robinson, 2008).

Changes in IT services often lead to IT outages, which causes interdependent IT services to fail (Vlietland & van Vliet, 2014c). In other words, in case an ISP fails to deliver an IT service to a dependent ISP, the latter ISP can also not deliver its IT service. Currently many large companies suffer from these interdependent IT outages. For instance Research In Motion (RIM) experienced a devastating blow after their Blackberry service failed and users in Europe were unable to communicate for days (Thomson & Miller, 2012). Other examples are Lloyds, TSB and HBOS that were unable to service customers for a three-hour period when a major IT glitch hit Lloyds Banking Group (Flinders, 2014) and RBS presenting incorrect balances after a software failure that stopped processing payments (Scott, 2014). Many IT outages daily disrupt business workflows resulting in potential loss of market share and deteriorated operational profit (Evolver, 2014; Lerner, 2014). To limit the negative impact a fast response to IT outages is required.

To respond faster to events, large ISPs increasingly transfer to Agile methods (VersionOne, 2013). Agile methods promote continuous adaption instead of detailed

planning upfront, having its origin in the social constructionism philosophy. Agile is based on Lean thinking and has been primarily adopted by the software development community (VersionOne, 2013). The Agile manifesto laid out the underlying concept of Agile software development (Beedle et al., 2013). Agile primary targets software development (Beedle et al., 2013). Yet, IT operations and IT infrastructure departments maintain existing software and distribute new software to production. Agility in the IT Operations and IT infrastructure environment is therefore needed to prevent bottlenecks in the deployment process to production. To mitigate these bottlenecks Agile thinking has been introduced to IT operations, with DevOps and Continuous Delivery (Humble & Molesky, 2011; Loukides, 2012). The word 'DevOps' is a portmanteau of "development" and "operations", bridging software development, operations, and services (Loukides, 2012). DevOps encourages collaboration between IT development, IT operations and IT infrastructure, by building liaison relationships between teams and the automation of boundary spanning activities (Feitelson, Frachtenberg, & Beck, 2013; Humble & Molesky, 2011; Loukides, 2012). Continuous Delivery entails the automaton of the software manufacturing process, from concept to cash (Humble & Farley, 2010; Poppendieck & Poppendieck, 2007). With the implementation of Continuous Delivery software is automatically integrated, tested and deployed to production, to evade repetitive work and human error.

1.1 Main research question

In the previous section is explained that IT service networks transcend ISPs and cover software development and IT operations. Since Agile methods improve the performance of software development (Bosch & Bosch-Sijtsema, 2011), the question is how Agility can be utilized to improve the performance of an IT service network. The main research question for this dissertation is therefore defined as:

Main research question: How to 'improve' the 'Agility' of 'IT service networks'?

To answer that question an initial literature search on IT service networks was conducted. Table 1 shows four Google scholar search strings that represent the initial search and the Google Scholar results (hits). Beck (2010) states that theory in IT service research is underdeveloped. Also authors in the 'service supply' research field mention the lack of theory about networks and changes of services (Baltacioglu et al., 2007; Zailani & Kumar, 2011). Based on the statements of these authors and the small number of search results, was decided to further study IT service networks.

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Table 1, Search strings and Scholar Google hits

| Search string | Hits | Ranked hits reviewed |
|----------------------------------|------|----------------------|
| "IT service network" | 19 | All |
| "IT service network" performance | 8 | All |
| "IT service network" improve | 9 | All |
| "IT service network" Agility | 2 | All |

1.2 Literature review

To answer the main research question three literature reviews were conducted, in three moments in time, which is explained in the remainder of this section. Section 1.2.1 explains the literature review process. Section 1.2.2 provides the results of the first and second literature review. Section 1.2.3 provides the results of the third literature review.

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1.2.1 Literature review method

The literature review process has three phases: (1) planning the review, (2) executing the review and (3) concluding the review, based on Saunders, Lewis, and Thornhill (2011). Each phase was completed by a closing discussion with the supervisor. The phases of the third literature review were more iteratively performed, without explicit closing discussions.

Phase 2 of the literature review process was split in three stages to identify, select, assess and extract the information in the literature: (1) initial review online, (2) elaborate review after downloading and (3) storage and usage in EndNote. As selection criteria (a) the literature needed published by a scientific publisher and (b) the literature needed to help answering the research question. Books and business articles were considered supplementary sources, to support knowledge building about the research field.

Stage 1: At the first stage the literature was initially reviewed online, by reading the abstract and scanning the conclusion section. Google Scholar was used as search engine for the literature search. Full access to scientific libraries (e.g. IEEEExplore, ScienceDirect and SpringerLink) via Google Scholar was achieved with the library account of the university.

The Google search algorithm carries a risk of missing the least cited scientific literature (Google, 2015), as citation count is the highest weighted factor in the ranking algorithm (Beel & Gipp, 2009), which strengthens the Matthew effect (Merton, 1968).

The risk was mitigated by snowballing (tracing back references in the identified literature). The residual risk was acknowledged and accepted.

The number of ranked search results (on which the initial review was carried out) usually varied between 30 and 80 hits. The number of initially reviewed results depended on the contribution of answering the search question in the higher ranked reviewed articles (search results). In case the search resulted in many articles that helped answering the research question, the search string was combined with other keywords to limit the number of hits. A used search string was stored in Excel, including the number of hits. Literature that met the selection criteria was downloaded and locally stored in a directory.

Stage 2: At the second stage the downloaded articles were reviewed in more detail, by reading the method section, the results section, and then the rest of the article, if applicable. To speed up the reading process, keyword searches in the reader were performed, based on the search strings. With snowballing techniques additional related work was identified.

Stage 3: The articles that passed the second stage of the review were categorized and uploaded in Endnote, for referencing in own work. At that stage key-sentences with the reference were copied in Word documents for future usage.

1.2.2 *First and second literature review results*

The first literature review was performed in 2010 at the beginning of the Master thesis (Vlietland, 2011), taking approximately three months. The second literature review was performed in 2011 at the start of the PhD, taking one month, to increase the rigor of the literature review. Both literature reviews aimed identifying literature about performance improvements in the IT service network research field.

Based on the initial search results the search string 'IT service network' was loosened to "IT service" and 'network'. Of that search the first 100 search results were reviewed, which resulted in four classifications of related work: (1) Technical IT services (e.g. Chen, 2008; C. Lee & Helal, 2002; Meshkova, Riihijarvi, Oldewurtel, Jardak, & Mahonen, 2008), (2) IT outsourcing (e.g. Currie & Seltsikas, 2001; Earl, 1996), (3) IT service management (e.g. David, Schuff, & St Louis, 2002; Lemoine & Dagnæs, 2003; McNaughton, Ray, & Lewis, 2010; Tan, Cater-Steel, & Toleman, 2009a; Winniford, Conger, & Erickson-Harris, 2009) and (4) Supply chains and logistics (e.g. Min & Zhou, 2002). Literature about technical IT services was not taken into account, as that literature has a technical perspective on IT services, while the research in this dissertation uses a human collaboration perspective.

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A subsequent literature review was then performed in the remaining three fields of related work: (1) outsourcing - as multiple outsourcings relationships resembles a service network, (2) IT service literature – as IT services are the actual objects that are delivered in the network and (3) non-IT related supply chains and supply networks - given the potential similarity with IT service networks. To that purpose alternatives for the main keywords ‘IT service network’ and ‘Improving’ were identified in the three fields of related work. Table 2 shows the overview of the alternative keywords.

Table 2, Typical keywords and conclusion identified literature

| Year | Main keyword | Alternative keywords | Conclusion identified literature |
|-------------|--------------------|---|---|
| 2010 – 2011 | IT service network | IT service, provider, supply chain, network, outsourcing, performance | Lack of IT service network perspective IT service limited to a dyadic perspective |
| | Improve | Improving, improvement, quality, information, sharing, visibility | Lack of IT service network perspective Closest match improvements in supply chains |
| 2013 | Agility | Agile, Scrum, Continuous Delivery, DevOps | Lack of IT service network perspective Limited to a software development context |

For the subsequent literature review 96 search strings were compiled, based on the combination of ‘IT service network’ and ‘improving’ or alternative keywords. A new combination was compiled based on the search results of previous combinations. For instance the combination “information visibility ‘service supply chain’ ” resulted in 83 hits about service supply chains. The next search string was therefore further tightened to: “ ‘information visibility’ ‘service supply chain’ ” resulting in 14 hits. During the first and second literature review a total of approximately 500 papers passed stage 1 and 169 papers passed stage 2 for uploading in EndNote.

While a large body of literature about improvements in supply chain, outsourcing and IT service settings was identified, the literature was insufficient for answering the main research question. Literature about supply chains provided insufficient answers because of the differences between product delivery and IT service delivery (Jansen & Cusumano, 2013; Parasuraman et al., 1985). In the field of outsourcing and IT services the literature provided insufficient answers because of the dyadic perspective.

Based on the results of the literature review the decision was made to perform empirical research to answer the main research question. The remainder of this section provides a representative overview of the literature that was identified during the literature review.

Related literature as result of alternative keywords for 'IT service network'

Related literature exists in the area of Supply Chain Management and Service Supply Chains (Ahlstrom & Nordin, 2006; Zailani & Kumar, 2011). The developed service supply chain framework of Baltacioglu et al. (2007) models the core processes for service supply chains. Although these processes have similarities with IT service processes (van Bon et al., 2007) it remains ambiguous whether the proposed processes fit IT service networks. Another case study with a supply chain perspective in the IT industry was conducted by Yu, Suojapelto, Hallikas, and Tang (2008). Their article identifies the potential complexity of IT service networks and similarities with supply chain networks. However their results have insufficient detail for answering the main research question.

In the area of outsourcing an overview of outsourcing literature is provided by Lacity, Khan, and Willcocks (2009). Many of the supply chain articles in that overview were reviewed during the literature review. All reviewed articles have a dyadic perspective, not a network or chain perspective. Additional Google scholar searches in this research field also resulted in literature with a dyadic perspective (Hatonen & Eriksson, 2009), including multi-vendor outsourcing literature (Cohen & Young, 2006). That dyadic perspective also exists in IT service delivery literature (Kumbakara, 2008; Rosa, 2012). Moreover, IT service literature typically targets IT processes in the IT operations field (Jantti, 2011; Jantti & Suhonen, 2012; Tan, Cater-steel, & Toleman, 2009b; van Bon et al., 2007), without having an Agile view (Kang & Bradley, 2002; Niessink & van Vliet, 1999).

Related literature as result of the literature review on 'Improving'

Literature about performance improvements exists in various related fields. One related improvement field is identified in supply chain literature. A factor for improving supply chain performance is information and knowledge sharing (Prajogo & Olhager, 2011; Rashed, Azeem, & Halim, 2010; Sahin & Robinson, 2005). Another factor related to information and knowledge sharing for improving supply chain performance is information visibility (Bartlett, Julien, & Baines, 2007; Caridi, Crippa, Perego, Saianesi, & Turmino, 2010b). A lack of visibility also causes bullwhip effects, resulting in large fluctuations in inventory, extending the time of delivery in supply chains (Bhattacharya & Bandyopadhyay, 2011; H. L. Lee, Padmanabhan, & Whang, 1997; Viswanadham, Desai, & Gaonkar, 2005). The third related factor targets collaboration improvements in supply chains (Cao & Zhang, 2011), which is related to shared information and shared knowledge (Banbury, Helman, Spearpoint, & Tremblay, 2010; Fuks et al., 2008; Wood & Gray, 1991).

A large body of improvement literature in the area of IT service delivery was identified (Jantti, 2011; Jantti, 2012b; Jantti & Järvinen, 2011; Niessink & van Vliet, 1998; Tan et

al., 2009b). The work of Niessink (2001) resulted in the ITS-CMM framework (Niessink & van Vliet, 1999) for the support of IT service improvements. While the model acknowledges linking IT services (e.g. by the term 'Integrated Service Management'), the model does not have an IT service network perspective. After publication of ITS-CMM the service delivery perspective was integrated in the Capable Maturity Model Integrated (CMMI), with CMMI for Services (Team, 2010b), without any guidance for improving chains and networks of IT services.

1.2.3 *Third literature review results*

Answering the first three research questions (see section 1.3) resulted in new scientific insights. Those new insights initiated a third literature review in 2013, performed in the field of IT service network Agility. The literature review with a one month duration resulted in the third category of related work, as shown by the typical keywords in Table 2. Even though there is a large body of Agile literature, no literature was identified that uses an IT service network perspective. Moreover Agile literature targets software development, not the full IT service lifecycle (e.g. IT operation). The remainder of this section provides the representative overview of the identified literature in this field.

Related literature as result of the literature review on 'Agility'

Agile literature is identified in the field of distributed software development (S. Lee & Yong, 2010; Sutherland, Schoonheim, Rustenburg, & Rijk, 2008). Sutherland, Viktorov, Blount, and Puntikov (2007) consider three models for collaborating Scrum teams in a distributed context. Sutherland, Schoonheim, and Rijk (2009) propose a setup for multiple collaborating Scrum teams. All identified research on such collaborations (Bosch & Bosch-Sijtsema, 2010; Hildenbrand, Geisser, Kude, Bruch, & Acker, 2008; Oppenheim, Bagheri, Ratakonda, & Chee, 2011; Sharp & Robinson, 2010) do not have an IT service network perspective.

That lack of IT network perspective also exists in scaled Agility literature (Larman & Vodde, 2008; Schnitter & Mackert, 2011; Sutherland, 2001). Rautiainen, von Schantz, and Vahaniitty (2011) study the introduction of portfolio management to support scaled Agile development, without clearly describing whether the studied case has a network setting. Other authors identify coordination as a variable that affects scaled Agile effectiveness (Begel, Nagappan, Poile, & Layman, 2009; Costa et al., 2011; Paasivaara, Lassenius, & Heikkila, 2012). Larman and Vodde (2013) use feature teams and liaison relations (J.R. Galbraith, 1971) with communities of practice (CoP) for exchanging knowledge and coordination between teams. All identified literature on coordination do not mention networks as a scaled Agile setting.

Ambler (2009) uses a more abstract view on scaled Agile by identifying eight scaling complexity factors: (1) team size, (2) geographical distribution, (3) regulatory compliance, (4) domain complexity, (5) organizational distribution, (6) technical complexity, (7) organizational complexity and (8) enterprise discipline, while also lacking an IT service network perspective for a scaled Agile setting.

Several other authors discuss Continuous Delivery for enabling Agility by IT process automation (also named IT4IT), without mentioning a network setting (Humble & Farley, 2010; Olsson, Alahyari, & Bosch, 2012). Literature on Agile/DevOps, being a collaboration philosophy between dependent staff, was either not peer reviewed (Humble & Molesky, 2011; Phifer, 2011), or not having a IT service network perspective (Humble & Molesky, 2011).

The relationship between Agile projects and software process improvement is studied by Salo and Abrahamsson (2005). To improve the adoption of Agile methods Qumer and Henderson-Sellers (2008) present a framework. Several other authors also study the adoption of Agile methods (Pikkarainen, Salo, & Still, 2005; Ringstad, Dingsøy, & Moe, 2011). An elaborate review of prominent work in the area of Agile improvement is performed by Akbar, Hassan, and Abdullah (2011). None of the Agile improvement literature uses an IT service network perspective, which is necessary to answer the main research question.

1.3 Research questions

To answer the main research question the decision was made to conduct empirical research. To that purpose the main research question was split into five (sub) research questions. Each of these questions was empirically studied. Answering these sub questions built sufficient knowledge and insight to answer the main research question. Since interdependence in IT service networks likely affect IT service network performance (Cao & Zhang, 2011; Wilhelm, 2011), the research starts by studying the interdependencies between ISPs, teams and staff. Social network theory helps modeling the interdependencies. According to social network theory, interdependent ISPs, teams and staff form networks, consisting of nodes and links (Freeman, 1979). The ISPs, teams and staff are represented by nodes, while the interdependencies are represented by links. Figure 1 shows an abstraction of an IT service network with nodes and links.

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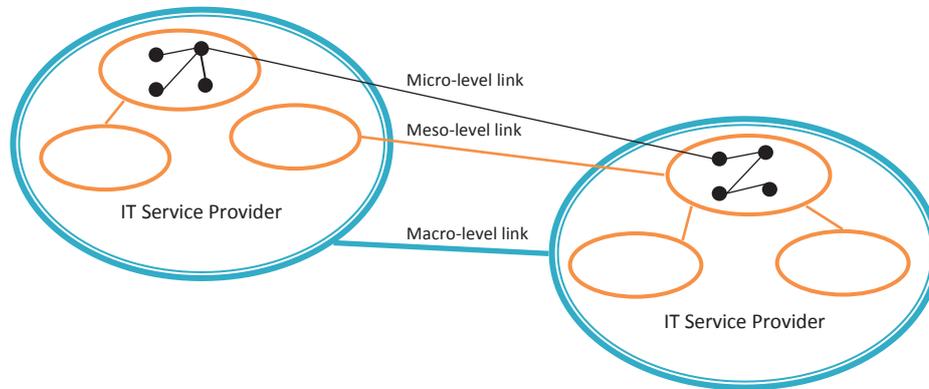


Figure 1, graphical representation of an IT service network

Macro-level nodes represent ISPs, illustrated by blue ovals. Blue lines illustrate the interdependencies between ISPs. Meso-level nodes represent teams within ISPs, illustrated by orange ovals. Orange links illustrate the interdependencies between teams. Micro-level nodes represent staff within teams, illustrated by black dots. Black links illustrate the interdependencies between staff. In order to enhance the understanding of the impact of these macro-level, meso-level and micro-level links the first research question is defined as:

RQ 1: What IT service network interdependencies affect IT delivery in IT service networks?

This research question triggered the study of literature that is related to IT service networks, being supply chain literature. In the supply chain literature Service Supply Chains (SSC) consists of multiple supply chain partners jointly delivering added value (Basole & Rouse, 2008; Sugumaran & Arogyaswamy, 2003). Supply chain partners resemble ISPs and teams in three ways: (1) Services delivered by supply chain partners resemble IT service delivery by ISPs (Yu et al., 2008), (2) both supply chain partners and ISPs have interdependencies and (3) tasks placed on backlogs of teams within ISPs resemble product stocks in supply chains. Given the resemblance between supply chains and ISPs, existing supply chain theory is utilized for this dissertation.

Research in SSCs shows that information needs to be shared between supply chain partners (Bartlett et al., 2007; Wei & Wang, 2010). Such information sharing requires that information is 'visible' to supply chain partners. The visibility of information is a well-known concept in the supply chain literature (Barratt & Oke, 2007; Bartlett et al., 2007; Caridi, Crippa, Perego, Saianesi, & Turmino, 2010a; Caridi et al., 2010b; Francis, 2008; Wei & Wang, 2010; Zhang, Goh, de Souza, & Meng, 2011). Supply chain visibility

is defined by Francis (2008) as "the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events". Based on the definition of Francis (2008) visibility is in this thesis defined as: "*the quality of known information characterizing predefined entities in a predefined IT domain*". Information visibility helps for instance interdependent partners to reduce the fluctuation of inventory by optimizing the flow of goods (Banbury et al., 2010; Bhattacharya & Bandyopadhyay, 2011). Given the similarities between IT service networks and supply chains information visibility is probably also applicable to IT service networks. The question is which information needs to be visible. Research in the supply chain industry has identified information that needs to be shared (Baltacioglu et al., 2007; Barratt & Oke, 2007) in supply chain networks. That information is not automatically equal to the information that needs to be shared in IT service networks, since supply chains are product oriented, while IT service networks are service oriented. In order to find the information that needs to be visible the following research question is defined as:

RQ 2: What information needs to be visible for IT delivery in IT service networks?

That research question triggered the question whether information visibility can be utilized for improving performance. Research in supply chain networks shows that enhanced levels of information visibility improve supply chain performance (Bartlett et al., 2007; Wei & Wang, 2010).

The performance of IT service networks can be measured in different ways. One way is using business value, which is considered a prime measure for IT performance by many (Alleman, Henderson, & Seggelke, 2003; Melville et al., 2004; Sutherland & Schwaber, 2013). ISPs deliver IT services to enable business processes that result in business value. Melville et al. (2004) study literature and model the relationship between IT services and business value that shows that the relationship is indirect and dependent on many (external) factors. Beccalli (2007) and Lin (2007) support Melville et al. (2004) regarding that indirect relationship. In this thesis the influencing (external) factors are eliminated by measuring IT service performance at the ISP side.

IT service performance of an ISP can be measured with subjective perceptions and by objective indicators. As perceptions are difficult to compare between case studies, the performance in this thesis is measured with objective indicators, allowing comparison over multiple case studies. For the objective performance indicators the common supply chain performance variables: flexibility, output, time, resources and flexibility (Cai, Liu, Xiao, & Liu, 2010; Huijgens, Solingen, & Deursen, 2014) are reused. The variable '*flexibility*' refers to the service supply chain responsiveness to changes in the

external environment that requires an IT service to change (Angerhofer & Angelides, 2006; Beamon, 1999). The variable '*output*' represents the delivered results against the requirements (Beamon, 1999; Gunasekaran, Patel, & McGaughey, 2004; Huijgens & Solingen, 2014; Shepherd & Günter, 2006). The variable '*resources*' represents the required resources to deliver the output (Bolstorff, 2003; Gunasekaran et al., 2004). The variable '*time*' represents the duration to deliver the output (Bolstorff, 2003; Shepherd & Günter, 2006). When the same output is achieved in less *time*, against equal *cost* with equal *resources* the performance of an IT service network is improved.

Stable IT provider networks with fixed *resources* are subject of study. Fixed *resources* prevent interference with the variables '*time*' and '*resources*', since adding resources impacts the duration (time) and output (results) (Bentley, Jones, Atkinson, & Ferguson, 2009). IT service networks with predefined *output* is subject of study. In case of IT failures the *output* is predefined by a restored operational IT service. In case of changes the *output* is predefined by the requirements that define the changed IT service. The variable '*flexibility*' is implicitly covered by measuring the responsiveness to change with the variable time and output. The variable '*flexibility*' is therefore not taken into account as an independent performance variable.

Given the similarity between supply chain networks and IT service networks, the causality between information visibility and performance probably also applies to IT service networks. Visibility of information eases information sharing resulting in improved IT service network performance (Bartlett et al., 2007). For instance information between IT teams about their performance enables teams to influence each other's performance (Banbury et al., 2010). Such influencing activities result in improved performance of the IT service network (Viswanadham et al., 2005). In order to test the hypothesized impact of visibility on IT service network performance, the following research question is defined as:

RQ 3: To which extent does visibility of information improve the performance of IT service networks?

That research question triggered the question which other factors affect IT service network performance. Larger ISPs have many teams that deliver IT. Each of these teams has staff with specialized skills that cannot be easily shared (Paasivaara et al., 2012; Christoph J Stettina, Heijstek, & Fægri, 2012). For instance one team changes and delivers the IT servers and a second team uses the servers to host a database platform. Together the IT results in an IT service that is delivered by the ISP (Chen, 2008). The combination of specialized skills and interdependencies require teams between and within ISPs to collaborate while handling IT failures and achieving IT

changes (Vlietland & van Vliet, 2014b, 2015b). Several factors that are related to such collaboration, probably impact IT service network performance.

Delivering IT services in a shorter timeframe is a measure for (IT service network) performance (Bolstorff, 2003; Shepherd & Günter, 2006) and a measure for (IT service network) Agility (Beedle et al., 2013; G. Lee & Xia, 2010). *Time*, or *duration*, is therefore identified as the performance variable for Agility in this dissertation. In order to find the collaboration related factors the following research question is defined as:

RQ 4: What collaboration related factors impede the Agility of IT service networks?

Since the collaboration related factors impede the Agility of an IT service network, the factors are defined as collaboration related issues (Vlietland & van Vliet, 2014a, 2015b). Alleviating these collaboration related issues likely improve the Agility of an IT service network. In order to test the impact of the alleviated collaboration related issues the following research question is defined as:

RQ 5: To which extent does alleviating collaboration issues improve the Agility of IT service networks?

The answer of RQ 1 and RQ 2 offer an in-depth insight into IT service networks which is used for answering RQ 3. Answering RQ 3 enhances the understanding of the impact of information visibility on IT service network performance. The knowledge about IT service networks, gained with RQ 1-3, is applied in the study of collaboration related issues in IT service networks, to answer RQ 4. The gained knowledge of answering RQ 1-4 is applied for developing a set of intervention actions for improving the Agility of an IT service network, answering RQ 5. By answering the last research question sufficient knowledge and insight has been acquired to answer the main research question.

For answering the main research question, the answers of RQ 1-5 are combined and generalized to develop a framework that improves the Agility of IT service networks. Such framework development is supported by Soundararajan and Arthur (2009) that argue that Agile practices need to be structured. The developed framework in this thesis contains intervention actions for improving IT service network Agility. Each of the intervention actions enhances IT service network Agility. The intervention actions have intended change as organizational change paradigm (Weick & Quinn, 1999). Intended change is an organizational change paradigm that impose interventions

actions to change a subject to a desired state. Existing organizational change literature is used as point of reference for developing the intervention actions (Cummings & Worley, 2014; Gersick, 1991; Hannan & Freeman, 1984; Kolb, 1984; Qumer & Henderson-Sellers, 2008; Weick & Quinn, 1999; Yamakami, 2013). The intervention actions are packaged into a framework. With that framework the main research question: “How to improve the Agility of IT service networks?” is answered.

1.4 Research methods

The presented research in this dissertation performs all phases of the empirical cycle (Groot & Spiekerman, 1969): observation, induction, deduction, testing and evaluation. *Observation* puts emphasis on the collection of empirical data. *Induction* aims to create propositions on the basis of the observations that explicate the observations. In the *deduction phase* propositions and additional related work are developed into hypotheses with dependent and independent variables to predict empirical contexts. During the *testing* phase the hypotheses are tested by collecting and analyzing new empirical data. *Evaluation* interprets specified hypotheses and theories and is interpretative by nature by generating new ideas for research.

The research methods in this dissertation are exploratory and confirmatory case studies. Exploratory case studies investigate distinct phenomena characterized by a lack of detailed preliminary research, especially formulated hypotheses that can be tested, and/or by a specific research environment that limits the choice of methodology (Mills, Durepos, & Wiebe, 2009). This form of case study is applied as a preliminary step for the development of a causal or explanatory research design. Confirmatory case studies test hypotheses, an outcome of predictions that are made before the measurement phase (Mills et al., 2009).

The data collection and analysis techniques include archival record study, surveys, interviews, transcriptions, coding techniques and focus groups. Interview results are analyzed by transcribing the recorded data. A three step qualitative coding technique is used to analyze transcribed data (Dul & Hak, 2012; Yin 2009). Subsequent quantitative analysis is performed on the code quantity in information categories (Saunders, Lewis, & Thornhill, 2009). Focus groups are setup after the events or experiences (Krueger & Casey, 2008) to evaluate the impact after the improvement interventions.

Table 3 shows (1) the overview of chapters, (2) the research questions that are covered in each chapter, (3) the segment of the empirical cycle that is performed, (4) the research design and (5) the used data collection and analysis methods in each chapter.

Table 3, Research overview

| Chapter | Research questions | Empirical cycle | Research design | Data collection and analysis |
|--|--------------------|---------------------------------------|----------------------|---|
| 1. Introduction | | | | |
| 2. Information sharing for effective IT incident resolving in ISP networks | RQ1 RQ2 | Observation Induction | Case study | Archival record study Interviews Transcription/coding |
| 3. Improving IT incident handling performance with information visibility | RQ3 | Deduction Testing Evaluation | Case study Survey | Archival record study Interviews Correlation analysis |
| 4. Towards a governance framework for chains of Scrum teams | RQ4 | Observation Induction Deduction | Case study | Archival record study Interviews Transcription/coding |
| 5. Delivering business value faster by sets of codependent Scrum teams | RQ5 RQ6 | Deduction Testing Evaluation | Case study | Archival record study Interviews/focus groups |
| 6. Improving the Agility of IT service networks | Main RQ | Induction | N/A | N/A |
| 7. Conclusions | | | | |

1.5 Chapters overview

Chapter 2: Information sharing for effective IT incident resolving in ISP networks

IT service networks need information to resolve IT incidents in their delivered IT services. The objective of the research is to identify the set of information that needs to be visible within IT provider networks to effectively resolve IT incidents. To this end, we conducted an inductive case study in a network of nine interdependent IT service providers. We found that the required information is distributed over multiple technological stores and that operational IT staff in the network need visibility over these technological stores. Operational staff also needs visibility over the social network of incident handling staff, given the tacit nature of the required information. We therefore premise that better information sharing and enhanced knowledge reuse in the service network has a positive impact on incident handling in IT service provider networks. The main contribution of this chapter is a structured set of information types that positively impacts IT incident handling performance in the IT service network. That structured set has been packaged into a conceptual model, answering research question RQ1 and RQ2.

Chapter 3: Improving IT incident handling performance with information visibility

We hypothesize that the knowledge IT teams in an ISP have of the agreed upon and realized incident handling performance of themselves and other teams will impact their performance. We tested this hypothesis at a large financial institute, using log data from the IT service management application and a survey to measure the knowledge of teams. We found (1) a significant positive correlation between incident handling performance of a team and the knowledge a team has of its own performance; (2) no correlation between the knowledge of agreed upon performance and realized performance within a team; (3) that teams have very little knowledge of agreed upon or realized performance of other teams; and (4) that improving the knowledge a team has of the agreed upon and realized performance of that team and dependent teams results in higher incident handling performance. The results show that increasing information visibility within and across teams in large IT providers is one way to improve incident handling performance. The results answer RQ3 in an intra-ISP context.

Chapter 4: Towards a governance framework for chains of Scrum teams

IT functionality in large enterprises is typically delivered by a portfolio of interdependent software applications involving a chain of Scrum teams. In this study we identify the collaboration related issues in a chain of Scrum teams. We used a qualitative approach with transcribed interviews from three case studies that were coded and analyzed to identify the issues. We identified six collaboration issues; coordination, prioritization, alignment, automation, predictability and visibility. These six issues answer research question RQ4. The synthesis of the issues with existing theory resulted in nine propositions. These nine propositions have been combined into a conceptual model. We used the conceptual model as a starting point to develop the Agile frameworks.

Chapter 5: Delivering business value faster by sets of codependent Scrum teams

In this study we develop a governance framework that packages five empirically tested intervention actions that alleviates the collaboration issues in sets of codependent Scrum teams. The effectiveness of the intervention actions was validated in a large confirmatory case study with a set of codependent Scrum teams at a multi-national financial institute, by studying the qualitative effects in archival records and measuring the change in cycle time within a specific workflow application. The effectiveness of the intervention actions was triangulated in three focus groups with members that operate in the set of Scrum teams. The intervention actions initiated a cycle time reduction from 29 days to 10 days. The participants in the focus groups confirmed the causality between the performance improvement of the set of codependent Scrum teams and the intervention actions. The main contribution of this chapter is a

governance framework for sets of codependent Scrum teams that support a value chain.

Chapter 6: Improving the Agility of IT service networks

Agility in networks of IT service providers helps to swiftly adapt interdependent IT services to changing business needs. In this chapter a set of intervention actions is developed to improve the Agility of these IT service (provider) networks. The intervention actions are based on Agile literature, organizational change theory and empirically confirmed collaboration related factors in Agile IT service networks. The intervention actions are packaged into an Agile 5+1 intervention action framework. The result is an Agile 5+1 framework to improve the Agility in networks of IT service providers.

1.6 Origin of chapters

The research in this dissertation has been published previously at conferences and in journals. The publications are included in subsequent chapter as-is, with the exception of some minor corrections. The research reported in this dissertation has been performed by Jan Vlietland as the prime researcher.

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Parts of chapter 2 have been previously published as: (Vlietland & van Vliet, 2013, 2014b):

- Vlietland, J., & van Vliet, H. (2013). *Visibility and Performance of IT Incident Handling: A Control Theory Perspective*. Proceeding of the Joint Conference of the 23rd International Workshop on Software Measurement and the 8th International Conference on Software Process and Product Measurement (IWSM-MENSURA), Ankara, IEEE Computer Society, 203-212.
- Vlietland, J., & van Vliet, H. (2014). Improving IT incident handling performance with information visibility. *Journal of Software: Evolution and Process*. doi: 10.1002/smr.1649

Parts of chapter 3 have been previously published by JSME as: (Vlietland & van Vliet, 2014c)

- Vlietland, J., & van Vliet, H. (2014c). Information sharing for effective IT incident resolving in IT service provider networks: A financial service case study. *Journal of Software: Evolution and Process*. doi: 10.1002/smr.1697

CHAPTER 1

Parts of chapter 4 have been previously published as: (Vlietland & van Vliet, 2014a, 2015b)

- Vlietland, J., & van Vliet, H. (2014a). *Alignment Issues in chains of Scrum teams*. Proceedings of the 5th International Conference on Software Business, Cyprus, C. Lassenius and K. Smolander (Eds.), Springer LNBP 182, 301-306.
- Vlietland, J., & van Vliet, H. (2014d). Towards a governance framework for chains of Scrum teams. *Journal of Information and Software Technology, Volume 57* (January 2015), Pages 52–65. doi: 10.1016/j.infsof.2014.08.008

Parts of chapter 5 are currently in process of being published by JSS as: (Vlietland, van Solingen, & van Vliet, 2015):

- Vlietland, J., van Solingen, R., & van Vliet, H. (2015). Delivering business value faster by sets of codependent Scrum teams: a governance framework. *Journal of System and Software*.

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Parts of chapter 6 have been previously submitted to ICSOB 2015 as: (Vlietland & van Vliet, 2015a):

- Vlietland, J., & van Vliet, H. (2015b). *Improving the Agility of IT Service Networks*. Proceedings of the 6th International Conference on Software Business, Portugal.