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Value Network Transformation

Digital Service Innovation in the Vehicle Industry

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Ph.D. thesis

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Value Network Transformation: Digital Service Innovation in the Vehicle Industry

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DOCTORAL DISSERTATION

Abstract

Advancement in digital technology is rapidly changing the contemporary landscape of business and associated networks for manufacturing firms. Many traditional physical products are now being embedded with digital components, providing them digital capability to become digitized products. The digitization of physical products has become an important driver for digital service innovation within manufacturing industries. Such digital service innovation transforms value networks of manufacturing firms in various industries. While digitization of products and digital service innovation can be observed in many manufacturing industries, this thesis focuses on the transformation of value networks within the vehicle industry.

This thesis is a collection of papers and a cover paper. The thesis reports from a collaborative project in the vehicle industry. The project explored new digital services for vehicles based on remote diagnostics technology. The exploration and conceptualization of digital services is investigated in a collaborative manner with participants from the vehicle industry. The results reflect that there is a paradigm shift for manufacturing firms digitizing their products, and stretching the business scope from product to solution oriented business.

This thesis contributes to the existing literature on digital innovation with insights on the transformation of value networks in the vehicle industry. The research question addressed in this thesis is: How are value networks of manufacturing firms transformed by digital service innovation? To answer the question, this thesis conceptualizes how the value creating pattern of digitized products transforms value networks of manufacturing firms. A model is presented that reflects how the symbiotic value relationship between the digitized product and digital services transforms the roles, relationships and exchanges in the value networks of manufacturing firms. The model can serve as an analytical tool to further advance the knowledge on business aspects in digital innovation. This thesis contributes to practice by providing an understanding of how manufacturing firms can leverage value of digitized products and digital services in value networks.

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To my parents, especially my mother for selfless devotion

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1. INTRODUCTION

Digitalization undoubtedly brings new value to manufacturing industries. Physical products in industries such as health care, aerospace, construction, energy, media, and transportation are embedded with digital technology. This trend is also eminent in the vehicle industry where digital technologies are embedded in products such as cars, buses and trucks. These products are referred to as digitized products (Svahn, 2012) and the process of digitizing products is termed digitalization (Yoo, 2013). Digitized products provide digital capabilities to capture and digitalize information that serve as the basis for digital services design. Digital services can be understood as the application of a firm's resources to provide digitally-enabled solutions to customers (Lyytinen and Yoo, 2002). Positioning services, remote monitoring and diagnostics for vehicles are a few examples of such digital services (Kuschel, 2009). The services are enabled by both digital and non-digital resources such as digital technology, digitized product information and product knowledge which firms have gained over decades (Jonsson, 2010).

Digital services can provide benefits to business as well as society at large. On the societal level, digital services can contribute to improved traffic safety, healthy vehicles as well as to efficient and safe public transportation. For businesses, predictive diagnostics information helps transportation companies to, for example, improve up-time of vehicles, improve maintenance and reduce the risk of failures in traffic. Moreover, digital services can contribute to increase flexibility in traffic planning by providing information about vehicles in advance. The services can unquestionably bring new value to manufacturing firms. However, it has also proved challenging (Kuschel, 2009). In response to these challenges and potential business benefits, the firms vision to expand existing product business by incorporating digital services. In this thesis, manufacturing firms refers to firms that have a tradition of manufacturing physical products and that now are entering the realm of digital services. As a result, the traditional business of manufacturing firms is transforming from selling products to selling solutions (Baines et al., 2009; Gustafsson et al., 2005).

In this transformation, firms are innovating their business and rethinking value. The opportunity to innovate product business by digitizing products and offering digital services is, however, challenging to manufacturing firms in the vehicle industry (Henfridsson et al., 2014; Kuschel, 2009; Svahn et al., 2015). First, incumbent firms' long-established transactional product sales business models are challenged. Second, the value chain thinking which emphasizes a linear, stable, hierarchical and centralized control over value creation is challenged (Peppard and Rylander, 2006). As a consequence, digital innovation transforms

firms' relationships, roles and the value creation structures. In contrast to value chain structure, value in digital innovation is created through non-linear, distributed control and dynamic processes in networked environments (Svahn and Henfridsson, 2012; Åkesson, 2009). In these networked environments, manufacturing firms are revising their existing perceptions about business models and value creation as a consequence of digitization of their products (Westergren, 2011; Åkesson, 2009). However, to leverage value from digitized products, the pattern of how value is created needs to be understood as well as its influence on the value networks. Consequently, there is a need to understand the dynamics of the networks where value is created in the course of digital service innovation (Barrett et al., 2015; Åkesson, 2009).

The networked environment in digital innovation can be understood in terms of value network¹ where different roles (e.g. suppliers, customers, providers) are bound by relationships. These roles are involved in both economic and non-economic exchanges to create value (Barrett et al., 2015). According to IS literature on digital innovation, value networks are considered as the core context of digital innovation (see e.g. Yoo, 2013; Yoo et al., 2010). Digital innovation is characterized as networked and dynamic, exhibiting distributed control (Barrett and Davidson, 2008; Svahn et al., 2009; Yoo et al., 2010). Digital innovation brings a shift not only in technology but also to existing relationships within value networks in industries (Abernathy and Clark, 1985; Selander et al., 2010) and changes the value creation patterns within the networks (Åkesson, 2009).

The inherent value of digital innovation is realized through a value creating process (Chesbrough and Rosenbloom, 2002) that challenges existing relationships and structures. For example, the advancement in digital technology may cause migration of innovation to new networks, and new technological paradigms may lead to emergence of new value networks (Christensen and Rosenbloom, 1995). Accordingly, digital innovation is not only reshaping the organizational structures but also business structures (see e.g. Chesbrough and Rosenbloom, 2002; Morgan et al., 2013). Given the IS discourse of knowledge on digital innovation, this is likely to occur for manufacturing firms digitizing vehicles and embarking on digital service innovation. There is, however, limited empirical IS research on the role of digital technology in the value creation of digitized products, and how the value networks of manufacturing firms are transformed in digital service innovation (see e.g. Barrett et al., 2015; Nambisan, 2013; Yoo, 2013).

¹ In literature, the networked environment is labeled as ecosystem (see e.g. Selander et al., 2010). In this thesis, I use these terms interchangeably.

1.1 RESEARCH QUESTION AND APPROACH

Over the last 15 years, IS researchers have examined the role of digital technology in creating value for firms and building sustainable competitive advantage (Grover and Kohli, 2012; Nevo and Wade, 2011). Similar advances have been made to study the influence of digital technology on firms' strategies, structures and processes (Sambamurthy et al., 2003; Sambamurthy and Zmud, 2000). More recent work has paid attention to the implications of digital innovation in value networks (Åkesson, 2009), identities of firms within a network (Nylén, 2015), inter-organizational networks (Westergren, 2011), and transforming relationships within networks (Selander et al., 2010).

There is a body of knowledge in the digital innovation discourse within IS on how firms in manufacturing industries are challenged in digital innovation. It has been established that firms are entering into a digital era, and require new capabilities and business logic for digital services, as well as a change in organizational culture (Yoo et al., 2010). Further it has been acknowledged that businesses structures of incumbent manufacturing firms are transforming from value chain to value network in digital innovation (see e.g. Allee, 2008; Christensen and Rosenbloom, 1995; Lusch et al., 2010; Peppard and Rylander, 2006; Åkesson, 2009). There is however limited knowledge on how value networks of incumbent manufacturing firms are transformed in digital innovation as a result of digitization of physical products (Yoo, 2013).

Recent literature on digital innovation suggests that more research on the transformation of value network in digital service innovation is needed to understand how digitization of products and services transform manufacturing businesses. This is specified in the IS community research agendas and calls for research on digital service innovation. The need for empirical studies is emphasized in these agendas and calls for research (Akaka and Vargo, 2014; Barrett et al., 2015; Lusch and Nambisan, 2015; Yoo, 2013; Yoo et al., 2010). In response to this research gap and these calls for research, this thesis focuses on value networks transformation in digital service innovation driven by digitized products with the following question:

How are value networks of manufacturing firms transformed in digital service innovation driven by digitized products?

The aim of this thesis is to contribute with a theoretical view on how digital service innovation transforms value networks of manufacturing firms to guide future studies as well as practice. Based on digital innovation literature, the concepts related to generativity of digitized products (see e.g. Tilson et al., 2010; Yoo, 2013; Zittrain, 2006) guided my research. The concept of generativity helped to describe the value relationship between digitized

products and digital services. To explain the service business of manufacturing firms, this thesis applies the perspective of value network (see e.g. Lusch et al., 2010; Normann and Ramirez, 1994; Peppard and Rylander, 2006; Åkesson, 2009). In a value network, the concept of role (see e.g. Ghazawneh and Henfridsson, 2015; Wareham et al., 2014) was used to represent individuals, departments and firms. Furthermore, to investigate the links between the roles, this thesis incorporates the concept of relationship (see e.g. Chesbrough, 2006; Selander et al., 2010; Simard and West, 2006). Finally, the transactions between roles are investigated with the help of exchanges (see e.g. Allee, 2008; Basole and Rouse, 2008). This thesis conceptualizes how the value creating pattern of digitized products transforms value networks with a model. The model reflects how the symbiotic value relationship between digitized products and digital services transforms the roles, relationships and exchanges in value networks. The model can serve as an analytical tool to further advance knowledge on business aspects in the digital innovation discourse of IS. This thesis contributes to practice by providing an understanding of how manufacturing firms can leverage value of digitized products and digital services in value networks.

To address the research question, I adopted a qualitative interpretive approach (Walsham, 2006) to obtain an overall understanding of transformation of value networks. The phenomenon has been studied in the context of businesses in manufacturing firms within the vehicle industry. The study reports from a collaborative project that aimed at exploring new digital services based on digitized vehicles and value creation of these services. By interpretatively analyzing data from different data sources, a wider understanding of the phenomenon was gained.

1.2 OUTLINE

The thesis is a combination of a cover paper and a collection of five individual papers. The cover paper presents the overall findings from the research study. Each of the individual paper addresses one or more aspects related to transformation of value networks in digital service innovation. The cover paper is organized as follows. This introduction follows a presentation of theoretical background in section 2. In section 3, I will present the research context of the thesis i.e. digitally enabled services in the vehicle industry. In the following section 4, I will present the research approach and method. Section 5 outlines the contributions from the individual papers and presents a model of value network transformation followed by implications for theory and practice as well as direction for future research. Each individual paper addresses various aspects of a value network that is transformed in digital service innovation. The papers included in this thesis are here listed in the order they appear:

COVER PAPER

- PAPER 1 Akram, A; Åkesson, M. (2011). "Value Network Transformation by Digital Service Innovation in the Vehicle Industry". 15th Pacific Asia Conference on Information Systems, 7-11 July 2011, Australia.
- PAPER 2 Chowdhury, S. and Akram, A; (2013). "Challenges and Opportunities related to Remote Diagnostics: An IT-based Resource Perspective". International Journal of ICT and Human Development (IJICTHD), Vol. 5, Issue 3, July-September 2013.
- PAPER 3 Akram, A., Bergquist, M., & Akesson, M. (2014). "Digital Visions vs. Product Practices: Understanding Tensions in Incumbent Manufacturing Firms". 47th Hawaii International Conference on System Sciences (HICSS) 2014. pp. 4516-4525. IEEE.
- PAPER 4 Akram, A., (2015). "The Influence of Generativity on Value Creation – A Study of Digitized Products". 8th IADIS International Conference on Information Systems, March, 2015, Madeira, Portugal.
- PAPER 5 Akram, A., Akesson, M., & Bergquist, M. "Balancing Generativity and Control of Digitized Products – A Study of Digitized Buses and Remote Diagnostic Services". Submitted to an international journal

2. THEORETICAL BACKGROUND

This section will provide a description of theoretical background to inquire the transformation of value networks of incumbent manufacturing firms. The section provides an overview of core concepts from digital service innovation and value networks. These concepts have been summarized at the end of each section.

2.1 INNOVATION

Innovation has been a key area of research in the field of information systems (IS). In a broader sense, the term can be used for ideas, practices, or objects that are perceived as new for society (Van de Ven et al., 1999). As the technology advances, innovation begins to relate to information technology (IT). This IT innovation requires significant organizational changes to realize the benefits. This means that innovation is not only a new idea, be it physical, digital or abstract, but it also requires the involvement of non-technical areas such as business, funding marketing, and human resources (Frankelius, 2009). In the digital innovation era, this suggests that new digital artifacts are entangled with social structures in organizations. As a result, connections are needed between different technical and social structures.

Innovation in IS literature is focused three areas: such as economic or business innovation (Schumpeter, 1934; Teece, 2010), open innovation (Chesbrough, 2006) and user-driven innovation (Von Hippel, 2005). In business Innovation practice, capital and profits are fundamentals in business cycles and are related to innovation (Schumpeter, 1934). According to Schumpeter (1934), economic development is driven by discontinuous emergence of new combinations (innovations) that are more viable than old ways of doing things. With this approach in mind, agility of business entrepreneur is an essential feature of business innovation (Sambamurthy et al., 2003; Sambamurthy and Zmud, 2000). The open and user-driven innovations require democratization, which is done by involving external stakeholders who have not been part of the innovation process (Di Gangi et al., 2010; Nambisan et al., 1999; Von Hippel, 2005).

Research on IT innovation can also be seen as process innovation and product innovation (Utterback and Abernathy, 1975). Process innovation refers to the processes where new ideas, practices and objects are developed. From this perspective, innovation is focused on finding more efficient ways for producing products and services. Process innovation can be defined in terms of invention, development and implementation of new ideas (Garud et al., 2013). Product innovation has been observed in many incumbent firms (Hill and Rothaermel,

2003) where a well-established, fixed and linear process is in place before the start of actual development with known stakeholders.

Traditionally, research on innovation in IS has focused on successful adoption of IT by organizations and sources for organizational development (Lyytinen and Yoo, 2002; Swanson, 1994). Recently digital innovation, has emerged as a new IS discourse. Digital innovation is defined as “the carrying out of new combinations of digital and physical components to produce novel products” (Yoo et al., 2010). Digital innovation differs from other forms of innovation primarily due to the architecture and the generativity of digital technology (Tilson et al., 2010; Yoo et al., 2010). In digital innovation, a firm extends its boundaries from the sphere of single organizations towards more networked markets (Lyytinen and Yoo, 2002). The digital innovation discourse (Yoo et al., 2010) and is gaining increased attention. (Bygstad, 2010; Svahn et al., 2009; Svahn et al., 2015; Tilson et al., 2010). This increase in attentions directly correlates with the increasing roles of services in digital innovation as presented in the recent research (Barrett and Davidson, 2008; Barrett et al., 2015; Lusch and Nambisan, 2015).

2.2 DIGITAL SERVICE INNOVATION

Digital service innovation refers to the service innovation in the digital age. The digital service innovation put an emphasis on the use of digital technology to design new digital services in varied contexts (Barrett and Davidson, 2008). As the result of digitization, new digital services can be produced from digitized products. The design of the services based on these digitized products is referred to as digital service innovation in this study.

A digital service is a new digital artifact gaining increased attention from IS scholars in recent years (Barrett et al., 2015; Nambisan, 2013). Digital services can be understood as the application of a firm’s resources to provide digitally-enabled solution to customers (Lyytinen and Yoo, 2002). However, a digital service can be used as a broader term encapsulating, for example, internet banking, call center services over the phone, electronic trading services, and so on (Barrett and Davidson, 2008). In the manufacturing firms, digital services contribute to an increase in services in contrast to traditional product focus (Oliva and Kallenberg, 2003).

At the very core of digital service innovation is digitization which refers to the encoding of analog information into digital format (Tilson et al., 2010; Yoo et al., 2010). Through this digitization, many traditional non-digital products, that is, physical products being embedded with digital technology into a traditionally non-digital product (Hylving et al., 2012; Yoo, 2013). Many physical products such as cameras (Tripsas, 2009), newspapers (Åkesson, 2009), phones (Ghazawneh and Henfridsson, 2013), and cars (Svahn et al., 2015)

are becoming digitized. With the advancement in technology, these digitized products can provide a much wider range of functionality than their analog counterparts. In some cases, the digitized products can serve as digital platforms for a multitude of digital services (Ghazawneh and Henfridsson, 2013). An example of such a digitized product is the smart phone. Aside from its basic functionality of making phone calls, a smart phone can, for instance, be used as a camera, a device to pay bills, a navigation device, or a personal health barometer. As the technology advances, smart phones can further be used to automatically upgrade software, or used as a mini computable device with applications previously only available on personal computers. Furthermore, a digitized product can be combined with other physical or digitized artifacts.

An important driver of digital innovation is digitalization, meaning that digitalization reshapes underlying social structures in digital innovation. Digitalization, in general, refers to the integration of digital technologies into everyday life. This has been defined as “the transformation of socio-technical structures that were previously mediated by non-digital artifacts or relationships into ones that are mediated by digitized artifacts and relationships” (Yoo et al., 2008, p. 5). Digitalization includes the extension and support of digital channels, content and transactions. An example of digitization is the process of embedding remote diagnostics technology into vehicles.

The research regarding digital innovation within manufacturing, and in particularly within the vehicle industry, has increasingly explored the consequences of digitized products and digitalization from different perspectives such as, architectural frames (Svahn, 2012), digital control systems (Lee and Berente, 2012), platform development (Lundbäck and Karlsson, 2005), user interface innovation (Hyvling, 2015), boundary spanning practices (Jonsson, 2010), and inter-organizational networks (Westergren, 2011). Furthermore, research on service innovation is wide and takes marketing aspects of products and service innovation into account (Vargo and Lusch, 2008) while leaving gaps for research on digital innovation aspects of the embedded digital technology and services (Barrett et al., 2015). Examples of such gaps include investigating how a digital technology influences value in networks (Barrett et al., 2015; Yoo et al., 2010), or investigating the implications for a firm's value through participation in a network (Ceccagnoli et al., 2011; Grover and Kohli, 2012; Han et al., 2012). Therefore, this thesis focuses on digital service in incumbent manufacturing firms and their role in the transformation of value networks.

2.2.1 CHARACTERISTICS IN DIGITAL SERVICE INNOVATION

Key characteristics in digital innovation are re-programmability, homogenization of data, and the self-referential nature of the technology (Yoo et al., 2010). Re-programmability relates to the ability of devices to be re-programmable and enable separation of semiotic functional

logic of device from physical embodiment. Homogenization of data means that data is presented in a homogeneous form, that is, all the data is represented in binary digits. The content can then be separated from the medium with emergence of new digital media. Finally, the self-referential nature means that digital technology is required for digital service innovation (Yoo et al., 2010).

The characteristics of digitized products influence the quality and characteristics of digital services. For instance, digital services may take on additional characteristics, such as storability and separation of production and consumption of services (Yoo et al., 2010). In the following scenarios, the technology has either reduced or eliminated the direct involvement of a service provider: self-services, such as internet banking, remote customer order entry and follow-on customer service systems (e.g. operator surveillance system). Furthermore, digital services are co-created with other actors in a network by sharing and using resources enabled by digital technology (Eaton et al., 2015). Mobile products such as vehicles are embedded with sophisticated computing capabilities (Jonsson, 2010; Kuschel, 2009) which serve to optimize the uptime of the vehicle. The advantage of using digitized artifacts include new dimensions to digital service relationships as embedded sensors can become the eyes and ears of a remote service provider who can access real-time data and in turn provide seamless services to customers.

2.2.2 GENERATIVITY OF DIGITIZED PRODUCTS

Generativity has been discussed along two different dimensions in IS and innovation literature. One dimension describes generativity as an attribute of a digital technology (Eaton et al., 2015; Zittrain, 2006). In terms of generativity as an attribute of technology, the term refers to “a technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” (Zittrain, 2006, p. 1980). Based on the capability or capacity of such a digital technology, firms can leverage the activities across a range of tasks with ease. The properties associated with the generativity are leverage, adaptability, ease of mastery, accessibility and transferability (Zittrain, 2006). The other dimension describes generativity as the ability of a person or a group who can reframe reality and produce something new in a particular context (Avital and Te'eni, 2009).

Manufacturing firms digitizing their products by embedding digital technology such as digital sensors the products are attributed with generativity. For example, sensors can measure the health status or condition of physical products such as vehicles, machines, etc. These measures are a resource that can be used to design new services, not anticipated when installing the sensors. Therefore, digitized products emerge as the result of digital technology being embedded within a physical product. Generativity of these digitized products is influenced by the architectures of both of these components, in the way of (i)

modular architecture of physical products; and (ii) layered architecture of digital technology. When these two architectures are embedded together, a continuum of modular and layered modular architectures is formed. As a result, generativity of digitized products is fluid along the continuum between modular and layered modular architectures (Yoo et al., 2010). Generativity in a layered modular architecture is accomplished through loose coupling across layers whereby innovations can spring up independently at any layer of digital technology's architecture which can affect other layers (Adomavicius et al., 2008; Boland Jr et al., 2007). For example, innovative services can be introduced by adding functionalities at the service layer. Similarly, new combinations of available data can lead to new innovative products at the content layer without being dependent on underlying layers.

An instance of such an innovation is combining available data regarding driving patterns or behaviors. This information can be used to further develop driver training programs. This layered modular architecture further inherits multiple design hierarchies, produces differences in kind rather than differences of degrees as possessed in traditional modular architecture. The components in this architecture belong to different design hierarchies (Yoo et al., 2010). For example, as most of the vehicles are becoming digitalized and connected through vehicle-based software architectures, it can not only be used as a driving tool but also as a digital platform where other firms can develop and integrate new devices, services and contents (Henfridsson and Lindgren, 2010). Overall, the generativity of layered modular architecture is dependent on a firm's ability to design a product platform that can attract a large number of heterogeneous and unexpected components. However, the generativity of layered architecture is constrained by the characteristics of vehicles' physical components, which are modular.

Today almost 50% of efforts for the development of a car go towards digital technology (hardware and software) components. Through the generative capability of the digital technology, digitized products enable digital services. Both the digitized products and digital services represent digital artifacts that are shaped by the interests, values, and assumptions of a wide variety of communities made up of developers, investors, and users (Orlikowski and Iacono, 2001). This means that a digital artifact emerges from interaction with the context in which it is developed. Influenced by this, generativity of these digital artifacts acquires the specific characteristics associated with the context. For example, generativity of digital artifacts in digital news media are interactive and able to be edited, transfigured, and distributed (Kallinikos and Mariátegui, 2011).

2.2.3 TRANSFORMATIVE DYNAMICS OF SOCIOTECHNICAL STRUCTURES

Digital technology has long been used in industrial settings and can be traced back to mid-1970s and early-80s. During this period digital technology was used for automation of work. This has raised the interest of IS researchers from both critical and socio-technical perspectives (Bansler, 1989). In the digital era, product innovation and IT innovation regimes are being diffused to give rise to a digital innovation regime. Digital innovation requires organizations to become proficient in both regimes simultaneously (Svahn and Henfridsson, 2012). Innovation in the product is characterized by modularity which defines the design rules for sub-systems and the interactions among sub-systems and components. Previous research on modularity has discussed its transformative power in relation to a sociotechnical perspective such the architecture of the products, (Ulrich, 1995) and the organizations of firms and networks (Garud et al., 2009; Sosa et al., 2007). This transformative power is enabled by the capability to design complex systems by dividing them into sub-systems and components. The design in modularity has a fixed boundary with centralized control and plans where components communicate through standard interfaces. Therefore, innovation in this regime is product-specific and influences the evolution of products. For example, this provides stability to products; increase speed, scope and reach of innovation through re-use of components. The dominant designs in product innovation emerge through standard interfaces which provide an economy of scale (Anderson and Tushman, 1990; Yoo, 2013; Yoo et al., 2010).

The modularity also has strong influence on the organization of firms. The standardized interfaces and invisible design parameters provide opportunities for transactions at a low cost. This allows firms to seek an external network effect by using expertise of specialized firms such as manufacturing firms that are only involved in making specific parts of a physical product. This pushes hierarchical firms towards decomposition due to their dependence on external firms (Baldwin et al., 2009; Langlois and Robertson, 1992). This is evident during the early developments of digital technology in various industries such as software and telecommunication. From a business perspective, the research has further discussed the influence of modularity on value chains that are traditionally integrated vertically to form value networks (Sosa et al., 2007). To achieve economic benefits, agility is a key source of value creation for incumbent firm (Sambamurthy et al., 2003). The benefits introduced were economic of scale, scope and substitution (Garud and Kumaraswamy, 1995) through the rapid recombination of components in product architecture.

Following the modular course of action, certain designs tend to become dominant (Anderson and Tushman, 1990). A dominant design reflects how a technology evolves and how it effects organizations and associated stakeholders (Anderson and Tushman, 1990).

Dominant designs further results in certain core capabilities, i.e. skills or abilities with ‘unique’, ‘distinctive’ and ‘difficult to imitate’ features (Meyer and Utterback, 1992). These core capabilities are described as ‘a set of differentiated skills, complementary assets, and routines that provide the basis for a firm’s competitive capacities and sustainable advantage in a particular business’ (Teece et al., 1997, p. 28). Although dominant designs help organizations to become efficient and competitive, they can also inhibit innovation. For example, a dominant design in the form of long-established institutionalized practices can hinder digital innovation in incumbent manufacturing firms. This phenomenon has been widely observed in the vehicle industry (Henfridsson et al., 2009; Hylving et al., 2012).

With the digitization of physical products, there is a need to account for changes accompanied as the result of new digital capabilities. These capabilities can extend or replace existing reliance on modularity (Yoo, 2013). The design within generative capability is emergent where the final design is not known in the beginning. The interactions between different components are provided by standard interfaces; however, there is no centralized control over design and coordination among elements. The concept of generativity is a powerful concept in describing transformation in a sociotechnical environment (Kallinikos et al., 2013).

A summary of the concepts described in this section are presented in Table 1:

Concept	Description	References
Digital service innovation	Refers to the service innovation in the digital age and emphasize use of technology in various contexts	Barrett et al. (2015); Lusch and Nambisan (2013); Yoo et al., (2010); Barrett and Davidson (2008)
Digital service	The application of firm’s resources to provide digitally enabled solutions to customers’ needs	Lyytinen and Yoo (2002); Nambisan (2013); Olivia and Kallenberg (2003); Barrett and Davidson (2008)
Digitized product	Physical products embedded with digital technology, having digital capabilities	Yoo et al. (2010); Yoo (2013); Svahn et al. (2015); Hylving et al. (2012)
Generativity of digitized products	An overall capacity of digital technology embedded in physical products to produce unprompted change	Zittrain (2006); Kallinikos and Mariategui (2011); Tilson et al., (2010); Yoo et al. (2010); Yoo (2013)

Table 1: Summary of concepts in digital service innovation

2.3 VALUE NETWORKS

The theoretical concept of value networks to understand networked innovation and business environments has been used in innovation research since the early 90’s (Allee, 2008; Christensen, 2013; Lusch et al., 2010; Normann and Ramirez, 1994; Peppard and

Rylander, 2006; Stabell and Fjeldstad, 1998). A value network is conceptualized as a set of connections between individuals, organizations, or individuals and an organization. The concept has interchangeably been used with 'value constellation' (Normann and Ramirez, 1994; Vanhaverbeke and Cloudt, 2006) otherwise known as 'ecosystem' in business related literature (Iansiti and Levien, 2004). The concept has been described by a number of researchers. For example, value networks rely on mediating technology to build relationships with customers (Stabell and Fjeldstad, 1998). A value network is defined as "Any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social good" (Allee, 2008, p. 6). This is also defined as being composed of complementary nodes and links (Peppard and Rylander, 2006). Despite various descriptions provided in the literature, a value network has three basic constituents: roles, relationships, and exchanges. It has been argued that to understand a value network, it is necessary to understand roles together with relationship types and the extent of these relationships (Basole and Rouse, 2008; Peppard and Rylander, 2006). The literature on value networks harmoniously recognizes value networks as an important concept to understand innovation (Vanhaverbeke and Cloudt, 2006).

As a reflection of that, value networks have been recognized as an important part of an innovation process, i.e., to explore and conceptualize the value during the innovation process. In this regard, value networks have been closely related to innovation networks in the innovation literature. During early phases of an innovation, value networks and innovation networks develop side by side (Vanhaverbeke and Cloudt, 2006). Both networks are sometimes considered as two sides of the same coin. Therefore, value networks focus on realizing and commercializing the inherent value of an innovation which is developed through an innovation network (Vanhaverbeke and Cloudt, 2006).

In digital service innovation, value networks consist of social and economic actors who propose values and interact through digital technology and institutions. These value networks co-produce services, exchange service offerings, and co-create value (Lusch et al., 2010). Digital service innovation not only transforms the roles in a value network, but also alters the relationships during an innovation. For instance, in the digital innovation of the newspaper industry, a newspaper reader converts to an e-reader customer and as a result, his or her relationship with news media has changed in a way that has far reaching implications for business models, design of services and interaction with the reader (Åkesson, 2009). Therefore, understanding how value networks are transformed in digital service innovation is important.

2.3.1 ROLES

There are many different roles in a value network on different levels; an individual, a group of individuals with a common interest, an organization, or a group of organizations. A role is defined as “an agent that is able to effect change through its own actions with technology, or is affected by a technological innovation and the related products and services changes due to the actions of another stakeholder” (Bardhan et al., 2010, p. 18). Examples of roles in a value network include consumers, users, buyers, innovators, producers, vendors, government regulators, user groups, and standards organizations. Depending upon the type of role, it can have economic driven or social welfare-driven concerns related to the economic, organizational, and technological issues that may arise. These roles can create influence or be subject to being influenced by technological advancement in digital innovation. For example, national political institutions (roles in the vehicle industry) in the US enforced the vehicle industry to produce local contents (Sturgeon et al., 2008). The definition implies that a role in a value network is (i) an active entity; (ii) has common interest towards an objective with other roles; and (iii) collaborative with other roles by sharing resources to achieve the defined objective. The term role has also been used as node (Basole and Rouse, 2008; Peppard and Rylander, 2006), actor (Stabell and Fjeldstad, 1998), or stakeholder (Bardhan et al., 2010) in relation to value networks. However, it is important to recognize that an actor can play multiple roles and a role can be played by multiple actors.

A role may be the main focus for dynamics of a value network (Allee, 2008; Åkesson, 2009). Roles in value networks are highlighted as imperative for successful digital service innovation, i.e., creating new value in a value network (Boudreau, 2012; Selander et al., 2010; Wareham et al., 2014). The two major concerns in this regard include whether multiple roles in a value network can participate in the value network and what position (i.e. key actor or shared responsibility) a particular role holds in the network. In traditional manufacturing value chains, the roles such as customers are typically stable and well known in advance (Jonsson et al., 2008). In digital service innovation, the roles vary from being highly selective to focused or specific (Ghazawneh and Henfridsson, 2015). The role that organizes networks and other roles circulating around it is considered as focal role (Raphael and Zott, 2001). Advancements in digital technology often redefine the roles, for example, of the service provider and the users (Tidd and Hull, 2003). Even referring to a particular focal role, its impact spans organizational boundaries (Raphael and Zott, 2001). However, there is a gap in the knowledge concerning how these roles change when incumbent manufacturing firms are digitizing products and incorporate digital services into their existing product business.

2.3.2 RELATIONSHIPS

Relationships are described as the way in which two or more people or things are connected. In a value network, relationships depict how two or more roles are bound

together in a value network. These relationships are characterized by being complex in an inter-organizational environment in contrast to a value chain where relationships are dyadic and follow a linear flow (Basole and Rouse, 2008). The relationships in value networks are linked by business models in the sense that they define the value creation process from which the different actors capture value (Chesbrough and Rosenbloom, 2002). The relationships depend upon the transactions in value networks. These transactions are based on currency or mechanisms of exchanges.

The nature of relationships within a value network plays an important role in innovation. In innovation literature, relationships are characterized along two dimensions in knowledge intensive services (i) deep-wide; and (iii) formal-informal (Simard and West, 2006). Deep ties within a network relate to homogenous knowledge, while wide ties refer to heterogeneous knowledge, which is more difficult to capture. The formal versus informal ties represent the difference between planned and contracted ties within informal and social contracts. Together, these ties form the different types of relationships between roles in a value network. For example, in informal networks controlling and managing the exchanges between roles is more difficult than in formal networks (Simard and West, 2006). These dimensions explain how relationships between different actors influence the innovation in a network (see Figure 1).

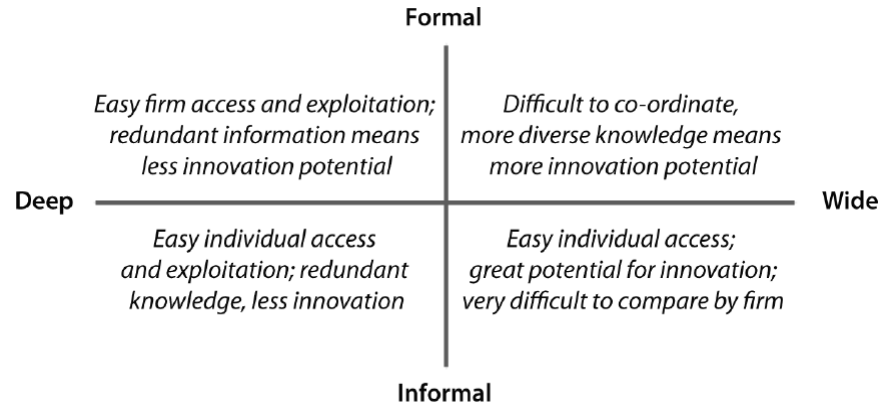


Figure 1: Dimensions of interfirm ties (Simard and West, 2006, p. 235)

Relationships in a value network are a web of direct and indirect ties between different actors where all the actors deliver value either to their immediate customers or to the end customers. For example, relationships between a focal actor and other actors, such as customers, suppliers, etc., provide business insights in a value network. This includes identification of customer segments and structures for value creation and value capture, (Chesbrough, 2006) meaning that different organizations have different value creation models within the same value network. For example, in the vehicle industry, an incumbent

manufacturing firm has a different business model than a public transport company. Likewise, the value network for each of the actors is different from others in the network since each actor has its own business focus. The relationships in a value network align roles to realized value, thus targeting a defined customer base (Chesbrough, 2006). The transformation of relationships within a network is influenced by tensions between collaboration and competing values (Selander et al., 2010). A value network shapes the roles in the value creating process (Christensen and Rosenbloom, 1995) and thus value is dependent on how the value networks are constituted and vice versa (Chesbrough, 2006). Therefore, roles and relationships form the basis constituents of value networks where value is created through exchanges.

2.3.3 EXCHANGES

Exchanges in a value network are the transactions, both economic and non-economic, in which different roles are engaged to achieve economic or a social benefit (Allee, 2008). The exchanges in a value network are done through one or more types of currency of exchanges. A currency of exchange represents the types of value exchanged between two roles in a value network (Allee, 2008). Currency of exchange is based on different kinds of assets and resources that roles use and share to create value. In the literature, different kinds of assets are used as currency of exchanges for value creation. The tangible exchanges mostly include monetary or economic exchanges, while intangibles include knowledge and other non-economic exchanges such as knowledge, feedback from customers and sense of market. Other researchers such as (see e.g. Marr and Chatzkel, 2004) provide specified categories of assets that can be used as currency of exchange to create value. These assets include financial assets (e.g. cash); physical assets (e.g. plants, equipment, land); human assets (e.g. knowledge, skills and experience); cultural assets (e.g. social capture and culture); practices and routines (e.g. internal practices, network routines); IP assets (e.g. patents, copyrights, trademarks, brands, registered design, trade secrets, and process ownerships); and even relationships between roles in a value network. In the context of digital innovation, digital technology enables additional IT-enabled intangibles as new currencies of exchange such as customer orientation, knowledge assets and synergy (Nevo and Wade, 2011; Nevo and Wade, 2010).

In the traditional value chain approach, currency of exchange is dominated by monetary or revenue exchange. However, in a value network, intangibles are of equal importance as revenue exchanges (Allee, 2008; Lusch and Nambisan, 2015; Lusch et al., 2010). The value in a network is transferred through the medium or mechanisms of exchanges based on both tangibles and intangibles (Allee, 2008). Although the factors governing the benefits can be economic (Christensen and Rosenbloom, 1995), non-economic exchanges can be converted to economic exchanges (Allee, 2008). This is more important when technology comes into

play and brings new kinds of exchanges (Basole and Rouse, 2008; Rai and Sambamurthy, 2006).

A summary of value network concepts are presented in Table 2 below:

Concept	Description	References
Value Network	A combination of roles and relationships that involved in tangible and intangible exchanges	Allee (2008); Stabell and Fjeldstad (1998); Peppard and Rylander (2006); Norman and Ramirez (1994); Selander et al. (2010); Lusch et al. (2010)
Roles	An active entity that has a common interest with others and collaborate with them by sharing resources	Bardhan et al., (2010); Allee (2008); Åkesson (2009); Boudreau (2012); Wareham et al. (2014); Ghazawneh and Henfridsson (2015)
Relationships	Relationships depicts how two or more roles are bound together in a value network	Simard and West (2006); Chesbrough and Rosenbloom (2002); Chesbrough (2006); Basole and Rouse (2008); Selander et al. (2010)
Exchanges	Exchanges in a value network are the transactions in which different roles are engaged to achieve an economic or a social benefit	Allee (2008); Christensen and Rosenbloom (1995); Rai and Sambamurthy (2006); Basole and Rouse (2008); Nevo and Wade (2010); Lusch et al. (2010); Lusch and Nambisan (2015)

Table 2: Roles, relationships and exchanges in a value network

These roles, relationships and exchanges are bound together to form a value network where roles are involved in exchanging both tangible and intangible currencies of exchange. These roles are linked in creating value in the value network. The roles, relationships and exchanges represent the constituents of a value network where value-creation is at the center of the value network. A general representation of constituents of value network is given in **Figure 2** below:

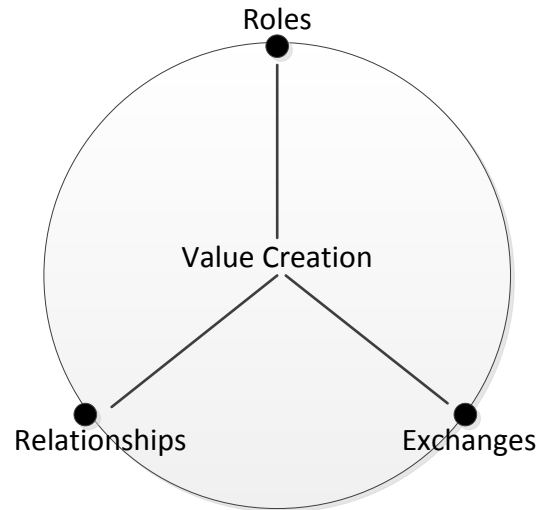


Figure 2: A model of value network constituents

2.3.4 VALUE NETWORK TRANSFORMATION

Digital technology is not only influencing the transformation of value creation within organizations at different levels, but within entire industries. This has resulted in the restructuring of business organizations, the nature of interactions among them, their boundaries, and the industries they operate in (Mendelson and Kraemer, 1998; Yoo et al., 2010). In digital service innovation, new challenges emerge ranging from managing relations with unfamiliar suppliers to devising complex strategies for differentiation and capabilities coupled with digitalization (Andreasson and Henfridsson, 2009; Hylving et al., 2012).

Value networks are recognized as dynamic and evolving which change over time (Christensen and Rosenbloom, 1995). This phenomenon is evident in many industries and sectors within these industries. For example, in the newspaper industry, digital innovation drives value networks to divergent structures whereas stabilization in business drives value networks to convergent structures (Åkesson, 2009). The advancement in technology may influence different processes of value creation, such as supportive processes, relationships with actors (e.g. customers, suppliers, and partners in incumbent manufacturing firms), and even the identity of an organization (Peppard and Rylander, 2006; Vanhaverbeke and Cloudt, 2006; Westergren, 2011). This opens a new area of research such as redesigning processes for providing services to customers and redesigning existing value creation structures. For instance, digital technologies affect the business in the manufacturing industry based on remote diagnostics services as it calls for new structures for value creation and relationship building (Jonsson et al., 2008). As a result, value networks need to re-organize relationships, roles and currency of exchange to adjust to the changing environment. The phenomenon is more evident in digital service innovation, where digital

technologies provide opportunity to firms in order to explore new value for services by building new relationships with both existing and new actors (Jonsson et al., 2008; Peppard and Rylander, 2006; Stabell and Fjeldstad, 1998). The value in these networks is driven by customers and developed through a complex web of direct and indirect relationships between network actors. Further, the complexity of value networks is influenced by the involvement of actors as well as an increase in their numbers. Here, digital technology plays an important role in reducing complexity by offering information and a means to anticipate changes (Basole and Rouse, 2008). Digital service innovation requires incumbent manufacturing firms to re-think their existing value chains and networks in order to cope with the changing environment.

In summary, it is well-established that businesses of incumbent manufacturing firms are transforming from value chain to value network with digital technology (see e.g. Allee, 2008; Christensen and Rosenbloom, 1995; Lusch et al., 2010; Peppard and Rylander, 2006; Åkesson, 2009), but less is known about how this transformation is influenced in digital service innovation (Barrett et al., 2015; Lusch and Nambisan, 2015). Therefore, this study focuses on business aspect of digital service innovation. The intermingling of technical and social features helps to conceptualize the value networks in digital service innovation as a complex, dynamic, emergent, and thus a sociotechnical phenomenon. The socio-technical perspective suggests that studying the relationship between digital and social is important due to a number of reasons. First, just like organizational phenomena (such as structure and culture), influence of digital technology is network wide and is not reducible to a single actor in a value network. Second, innovation in digital technology and services may affect every single actor within a value network. Finally, these interactions influence how value is created in value networks.

Given this theoretical background, transformation by digital service innovation involves changes in the architecture of digital artifacts, value creation structures, and eventually value networks. The value networks are transforming as firms in manufacturing industries are expanding their businesses with service economy enabled by digital service innovation (Barrett et al., 2015; Barrett and Prabhu, 2010; Lusch and Nambisan, 2015). Therefore, more research is required on how value creation of digitized products and related services transform roles, customer relations, and exchanges value network. In particular, there is a need for more research in IS contributing with an understanding of the transformation of value networks in industries, such as the vehicle industry.

3. RESEARCH CONTEXT – DIGITAL SERVICE INNOVATION IN THE VEHICLE INDUSTRY

The vehicle industry is primarily concerned with the design, development, manufacturing, marketing, and selling of physical products such as buses, cars, and trucks. The industry has a long established tradition of innovation in connection to its products. With the advancement in digital technologies, physical products are being converted into digitized products with capabilities to produce services. As a result, the industry is undergoing a shift in innovation from physical products only to digitized products and related services.

Today a vehicle is a complex mechatronic system comprised of physical and digital components. More than 80% of innovation in vehicles is based on the capability of these digital components (Broy, 2006). These digital components vary according to their functionality purposes such as sensors, ECUs, GPS and RFID tags. With the increased use of digital components, the vehicle industry is consolidating digital technology with their products. This consolidation brings many challenges to the industry such as the need for acquiring new competencies and processes for both software and hardware development (Williams, 2007).

In managing the dual regime of digital innovation, it becomes critical to organize logics and architectural design and deal with market dynamics (Henfridsson et al., 2009; Svahn and Henfridsson, 2012). As a result, traditional requirements in product innovation (e.g. linear process, vertical industries, firm-centricity, dominant design, economy of scale, and competition over prices) are challenged by digital requirements (e.g. non-linearity, horizontal structures, network-centricity, shared platform, a mass of niche market, and competition over attention). This requires a number of renewals in the business such as change in infrastructure and institutional practices, change in mode of producer-user interactions, change in vehicle ownerships structure, and change in relationship structure (Selander et al., 2010; Svahn and Henfridsson, 2012). Here, services are not only a support function to the vehicles but also a potential source for new markets.

In order to shift towards solution-oriented business, vehicle manufacturers are paying more attention to the uptime of the vehicles. In this regard, services such as repair and maintenance play a critical role in keeping vehicles up and running. To date, services have not been a main part of business for manufacturing firms, instead mostly treated as a support function for the vehicles. During a vehicle's life cycle, maintenance and repair services are typically not included in the manufacturing firms' main businesses, but as a part of the after sale business in the form of service contracts. Therefore, service innovation is

still an infant in the vehicle industry. However, digital innovation has motivated firms to include services as a part of their main business activities. An example of such potential services is remote monitoring and diagnostics services. These remote monitoring services can bring new revenues to the existing business (Kuschel, 2009). The basis of providing services is hinged upon relationships between manufacturers, their customers and other stakeholders who operate in a networked environment. However, this opportunity may present big challenges and contradictions to the manufacturing firms business. Traditionally, the business of a manufacturing firm relies on the sale of vehicles and vehicle parts. The new business approach focuses more on increasing service sales and reducing the sales of parts. Hence, both business approaches can inherently contradict each other. Other challenges include the design of new digital services by harmonizing a set of fundamental design objectives and a set of fundamental service provider objectives (Williams et al., 2010). In this thesis, I focus on the influence of value network transformation in the presence of digital and service innovation.

Most of the services in the vehicle industry are related to the maintenance of vehicles. Bus operating companies are growing more and more interested in the maintenance of vehicles and the related costs, particularly within their daily transport business operations. A maintenance service has two major parts: (i) diagnosing; and (ii) repairing the faults in the vehicles. However, diagnosing the faults using traditional human-based approaches is a troublesome and time consuming task due to number of factors, for example, lack of skilled personnel, time leakage and unnoticed errors (Jonsson et al., 2008). To address this issue, remote diagnostics technologies are being used to remotely and proactively diagnose the faults. A remote diagnostics system monitors and diagnoses the health of a vehicle using heterogeneous technologies such as embedded sensors, wireless networks, database management systems, analytics and operational rule systems. Based on the remote diagnostics technology, the incumbent firms are envisioning providing e-maintenance services to their customers. However, it is worth noting that remote diagnostics provide opportunities for incumbent manufacturing firms to develop a number of other services in addition to e-maintenance, such as driver training on the basis of driving patterns.

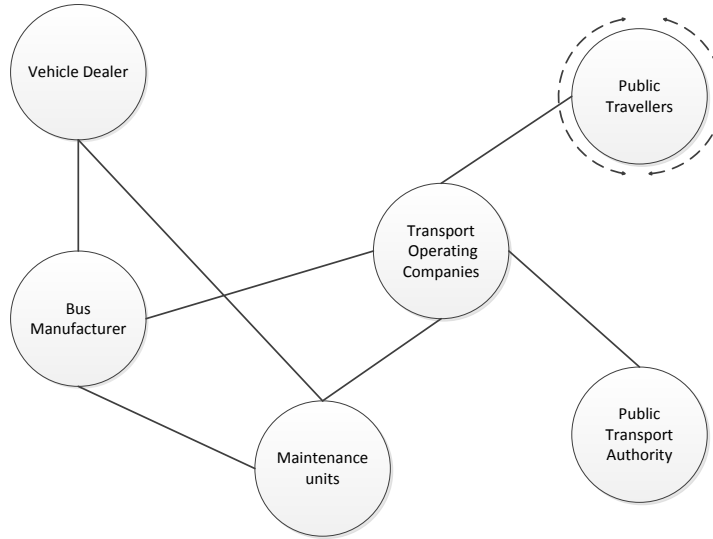


Figure 3: Roles with links in the vehicle industry

In order to provide maintenance services based on remote diagnostics, different actors are connected to form a value network. Figure 3 represents a general overview of value network in the vehicle industry. Bus manufacturers have an important position in the value network. These manufacturers provide vehicles (e.g. buses) to the transport operating companies directly or through dealers. The maintenance units are the workshops that provide repair and maintenance services on the buses. These units can be owned by bus manufacturers, vehicle dealers, or transport operating companies. The transport operation companies negotiate and sign a contract with public transport authorities in order to provide travel services to the public.

4. RESEARCH METHODOLOGY

In this section, I present the research methodology used to study the transformation of value networks. The section is organized as follows. I start by presenting the philosophical underpinning and the interpretive research approach. This is followed by a description of the project providing the empirical data for the research. Following the description of the project, I give a detailed account of the research design and how data was collected. I then describe how data was analyzed. Finally, I reflect upon my research process according to an established set of criteria of the research approach.

4.1 AN INTERPRETIVE APPROACH

This thesis adopts an interpretive approach to explore the transformation of value networks in digital service innovation. The interpretive approach is well-established in the IS field (see e.g. Klein and Myers, 1999; Myers, 1997; Orlikowski and Baroudi, 1991; Walsham, 1993; 2006). From a philosophical standpoint, the interpretive approach is grounded in the idea that our knowledge of the world is socially constructed. At core of interpretive approach is the hermeneutic circle and acknowledging the researcher's involvement, prior assumptions, beliefs, values, and interests.

Given that our knowledge of reality is socially constructed by human actors, meaning is created and associated when people interact with the world through representations such as language, consciousness, shared meanings and artifacts (Klein and Myers, 1999; Walsham, 2006). The subject matter of this research is value network transformation – a phenomenon that emerges from the interactions between digital technology and human actors. An interpretive approach requires a researcher to study a phenomenon by exploring the social construction of the meaning associated with the context of the phenomenon. The social construction assumes that technology and the organizational context develop in an ongoing mutual shaping process (Orlikowski and Baroudi, 1991). In this thesis, value networks are recognized as socio-technical structures of the interactions between digital technology and business activities in the networks. I therefore studied how value networks are perceived and constructed by stakeholders in a digital service innovation project. An interpretive approach resonates with the research question and phenomenon of the study.

Second, interpretive research is related with various qualitative research methods such as action research, case studies and ethnography in the IS field (Walsham, 2006). These methods have their own implications for the type of contribution and theory that can be developed (Gregor, 2006). A common denominator in all of these methods is the researcher involvement in the fieldwork. The involvement may vary from being a passive observant to

intentional action such as in action research. During the study, I participated in a collaborative research project where I collected data from various sources. My involvement in the project varied from being an active to a passive participant during the activities.

The hermeneutic circle is described as the fundamental principle for doing interpretive research in IS (Klein and Myers, 1999). The hermeneutic circle proposes that all human understanding is obtained by the iteration between the meanings of the parts and the whole. That is, the individual parts are understood with reference to the whole, and in turn, the whole is constructed from an understanding of the individual parts in an iterative manner. This meta-principle forms the basis for conducting and evaluating an interpretive research. Following this approach, my research process involved iterations between empirical and theoretical concepts. This means that the empirical concepts are guided by theoretical concepts and many empirical observations guided to new literature studies. Through this process, my understanding of value network transformation developed over time from contributions presented in individual papers. Switching between particular ideas, such as value perception of remote diagnostics technology and value network as a whole is an example of the iteration proposed by the hermeneutic circle principle.

The iterative process of the hermeneutic circle is influenced by prior assumptions, beliefs, values and interests of a researcher (Orlikowski and Baroudi, 1991). In my case, this prior understanding was linked to my educational and professional background in computer science as a technologist. During the project, I learned about the value networks of vehicle manufacturers. This learning and the involvement in the industry raised my attention to consider the social context in which the technology was being developed. Thus the project, hereby named the RDS project, was important to enhance my understandings of transformation of value networks.

4.2 THE REMOTE DIAGNOSTICS PROJECT

This thesis builds on a qualitative study conducted within a 3 year research project – Remote Diagnostics (referred as RDS project in this thesis) in the vehicle industry. The project was conducted between 2010 and 2013. The project involved Halmstad University, a vehicle manufacturing firm (pseudonym GlobalAlpha) and VINNOVA. The whole project is conducted as collaborative research with participants from the industry (Mathiassen, 2002). The project was initiated by GlobalAlpha and aimed to implement state of the art remote diagnostics services based on a remote diagnostics system. The technology used in the system involves monitoring the status of vehicles on roads from a remote location. On the basis of the monitoring, the system is capable of providing predictive diagnostics information regarding faults and errors in vehicles. To exploit the benefits from such a

capability of the technology, GlobalAlpha came with the vision to provide predictive maintenance and repair services complementing their existing product sale business.

The project was funded by the Swedish government agency VINNOVA within the FFI (Fordonstrategisk Forskning och Innovation - Vehicle Strategy for Research and Innovation) program "Transporteffektivitet - Effective Transport". VINNOVA is a research funding agency which provides funding for 'Innovation Systems' in Sweden. The agency aims at strengthening innovativeness, aiding sustainable growth and benefiting Swedish society. The primary outcome of the program is to promote innovative and sustainable solutions for effective transportation for organizations.

The project participants of the vehicle industry were a project manager, service developers, business area representatives, a maintenance manager, technology researchers and developers. The firms from whom data has been collected include a manufacturing firm – GlobalAlpha; three different business areas – Alpha 1, 2, and 3; three public transport operating companies – TOCs, A-TOC, B-TOC and C-TOC; and a public transport authority – PTA (see Table 3 below). Alpha 1, 2, and 3 are involved in the manufacturing of buses, trucks and construction equipment, respectively. These business areas also provide maintenance and repair services. Public transport companies are involved in providing transportation services to the society. Public transport authority is responsible for negotiating and materializing the transport services contracts for TOCs. A summary of these participants is presented in the Table 3 below:

Actors	Participants
GlobalAlpha	Service developers; technology developers; maintenance manager; business manager; project manager
Alpha 1	Business manager; maintenance manager
Alpha 2	Business manager
Alpha 3	Business manager
A-TOC	Manager; assistant managers; drivers
B-TOC	Manager; repair and maintenance personnel; driver
C-TOC	Manager
PTA	Manager
Halmstad University	Technology researchers and Informatics researchers

Table 3: Participants involved in RDS activities

GlobalAlpha holds a prime position of focal actor. The firm was established in the 1920s to manufacture safe vehicles of high quality for extreme conditions. The firm has more than 100 000 employees with production facilities in 19 countries and is selling products globally. Over decades, GlobalAlpha has expanded its manufacturing business into a number of areas such as: buses, trucks, construction equipment, automobile, marine and industrial engines, and components for the aerospace industry. The business area related to buses is one of the

world's largest manufacturers of heavy buses. It also delivers chassis, transport solutions and telematics systems. During GlobalAlpha's journey of developing a variety of high quality products, the firm started providing services as add-on functions to their products. Today, GlobalAlpha envisions providing new digital services in parallel to their traditional manufacturing business with the aim of providing sustainable transport solutions. A majority of GlobalAlpha customers are companies within the transportation or construction industries. GlobalAlpha experiences a high level of competition in the industry. The competitors are firms who manufacture similar kinds of vehicles and businesses. The company's sales have spread globally: 37% in Europe; 23% in North America; 23% in Asia; 10% in South America; and 7% in rest of the world. Being in the vehicle manufacturing business 73 % (more than two-third) of the firm's business revenue is obtained from selling physical products (aka hard products) while only 27% (less than one-third) of its revenue comes from sales of services and aftermarket products (aka soft products). The existing product life cycle is based on a sequential value chain system: product development, purchasing, production, distribution and service, product in use, and re-use.

GlobalAlpha has several interesting characteristics that makes it relevant object of study. First, it is an incumbent manufacturing firm in the vehicle industry mainly involved in the sale of physical products, that is, vehicles and their parts. Second, GlobalAlpha is involved in activities related to the development of predictive remote diagnostics technology. This diagnostics technology is embedded in their vehicles to convert them to digitize buses where new digital services can be developed. Third, GlobalAlpha is on its way to incorporate digital services into their products business. Fourth, on the basis of these digital services, GlobalAlpha is envisioning its business change from selling products to selling transport solutions. Finally, GlobalAlpha's customers (TOCs) are taking an interest in keeping their vehicles up and running. Therefore, the TOCs have concerns about the services related to the health of the vehicles.

The RDS project was divided into two parts running in parallel: technological development; and service development. The technological development part was aimed at developing remote diagnostics technology. This part included developing a technological solution as well as analyzing and presenting the information. The technological solution consists of an on-board data monitoring with capabilities to re-configure remotely and off-board software for communicating with the vehicle as well as analyzing the data. This part also included developing the algorithms to read on-board signals obtained from sensors and ECUs already installed on the vehicles. These on-board signals are then combined with off-board sources such as a usage statistics database and a maintenance record to assess the health of a vehicle. The data stored in database is heterogeneous as the model year and specification of the vehicle affect the parameters logged into the database. This makes it difficult to find

large datasets with a homogeneous set of parameters for technology researchers developing the solution. These researchers are more interested in developing new solutions using condition based methods. This includes finding new methods for combining on-board data (which is collected from sensors in the vehicles) with off-board data (which is collected from the database) to predict vehicle health status. Furthermore, on-board data have limited computation and storage capacity. Therefore, the technology researchers need to develop algorithms to compress data into a size that can be transmitted to a remote location. From a business perspective the data sources already exist with no further costs except for developing algorithms. Finally, the solution to detect the faults was developed and tested on a fleet of vehicles.

The service development part of the project was concerned with exploration and design of maintenance services based on remote diagnostics technology. For this purpose, GlobalAlpha adopted an iterative process divided into two phases: (i) the exploration phase; and (ii) the conceptualization phase. Seeing as GlobalAlpha has various areas of operations such as trucks, construction equipment and bus manufacturing. During the exploration phase, we decided to collect data from bus manufacturing. I collected this data together with another informatics researcher and a senior informatics researcher in the service development part. A service developer was also actively involved in different activities. The data collected during was shared among all project members. To investigate the influence on value network transformation by digital service innovation, this study reports from both phases as described below:

During the exploration phase, GlobalAlpha was interested in seeking out the potential of remote diagnostics technology and services that can be generated from said technology. At the same time, GlobalAlpha was interested in building knowledge of customer needs and finding business opportunities. During this phase, GlobalAlpha was also interested in finding and prioritizing all stakeholders; identifying target groups and markets; mapping customer existing business and developing initial value propositions that can address customer needs based on services. During the conceptualization phase, GlobalAlpha aimed at designing the services explored during the exploration phase together with customers and other stakeholders in the network. More specifically, GlobalAlpha was interested in uncovering hidden often overlooked patterns by customers; aligning a service strategy to the business strategy of the customer; clarifying a level of involvement for all stakeholders; and planning for iterations in the phases. The overall project design allowed moving both forwards and backwards during these two distinct phases of service development part.

4.3 RESEARCH DESIGN

A qualitative study was designed to explore the transformation of value networks. Qualitative research has the following characteristics: a natural setting, researcher as a key player; various types of involvement, multiple sources for data collection, emergent design, and a holistic account. These elements include studying a topic in a natural setting where researchers are key instruments in the process. These researchers gather data from multiple sources with capturing participants' meaning of the situation. Finally, the researchers try to get a holistic account through an emergent process (w Creswell, 2009; Walsham, 2006).

Using a theory to understand a phenomenon is common in qualitative research. However, "theory is both a way of seeing and a way of not seeing" (Walsham, 2006, p. p. 6). Subsequently, theoretical discussions drawn in the individual papers are used different theories to investigate the influence of digital service innovation on the transformation of value networks. For example, paper 4 use generativity concept to explain the value created in digital service innovation. Further, different theoretical lenses can be applied to the same data to increase the understanding of the phenomenon. Figure 4 (see page 38) shows the use of the same data such as interviews and meetings notes in multiple papers. However, it should be noted that the old data was combined with the new ones of the same and other types of data.

Characteristics of Qualitative Research Maintained in this Study

The RDS as a collaborative research project allowed me to collect data in the real-world setting where I as a researcher investigated the transformation of value network. During the initial phase of the project a strategy to collaborate was agreed upon. In this real-world setting, data was collected using direct interaction with participants from the industry. This direct interaction allowed me to capture data from GlobalAlpha and the other participants. The direct interaction also facilitated in capturing primary data such as interviews, workshops and meetings.

The project started in the autumn of 2009 with the technology part being launched first. My *involvement as a researcher* in the project started in April 2010 which was the same time that the service development part of the project was started. My involvement together with another informatics researcher ended with the end of the service development part of the project in June 2013. The involvement of a researcher in the qualitative research can be described as both an outside researcher and an involved researcher (Walsham, 2006). During the project, my role changed from an outside researcher to an involved researcher. I was an outside researcher in activities related to the technology development part of the RDS project. My involvement as an outside researcher included participating in project meetings. In these meeting, the participants discussed, for example, technological

challenges in developing remote diagnostic technology. In addition to being a passive listener, I also inquired about the characteristics, designs, and limitations of the technology.

I was an involved researcher in the activities related to service development part of the project. These activities included learning about customers' needs with TOCs, exploring and conceptualizing remote diagnostics services with TOCs, and meeting with employees at GlobalAlpha and project participants. I was actively involved in charting the firms existing business situation and exploring new value potentials of the services for different business areas of GlobalAlpha. It was important to actively gather information inside information about visualizing value network including actors, relationships among them, and types of currency exchanges. This active involvement helped me to identify the problems in the existing business and exploring new values with remote diagnostic services. In short, I was involved from being a 'passive' to an 'active' participant in data collection.

For a qualitative researcher, *gaining and maintaining access* to the real-world is crucial and requires a tactful act. Gaining access to other project members and data sources started by signing a confidentiality agreement. The agreement allowed me to enter the space where data from digitized vehicles were being collected and where services were being designed. Since I was a member of the project, I participated in meeting and other activities. Hence, gaining and maintaining access was not a problem such as during project meetings. These project meetings were held with the help of formal invitations and reminders through emails. There was also the opportunity to bring up a number of issues in advance, which I found was helpful to take advantage of. During this time, I also arranged meetings with other projects members when I felt it was needed. There were times when physical meetings were not possible which was hurdle due to project members from GlobalAlpha only being allowed to use internal communication systems for official meetings. To overcome this, project participants were given access to GlobalAlpha's communication system through which they could communicate and conduct meetings. During the project, it was also realized that project participants need access to GlobalAlpha's internal documents such as service records. The access issue to these documents and service records was solved by discussion with project manager. During project meeting, I also expressed my need to talk to other employees at GlobalAlpha such as business managers from the different business areas. I could access required personnel after describing the purpose of the activity. Maintaining access with other project members was possible through regular and on-demand meetings. Gaining and maintaining access to other stakeholder such as TOCs and PTA was approached through project manager and other technology researchers who were already involved in data collection from their vehicles. Another TOC from the industry showed interest to play an active role by participating in different activities. I conducted

interviews and a service design workshop with the representatives from the TOC. The company was later informed about the results of the findings through a formal report.

A qualitative research process is *emergent*, meaning that a plan for how to execute the research is not rigid in the initial stages. This allows researcher to change the details as the research progresses. For example, certain interviews inspired me to follow up studies on related studies pertaining to the opportunities provided by remote diagnostics technology. Likewise, it was my participation in the initial project meetings that led me to plan value network workshops to get an overall picture of the actors in value networks. Similarly, service design workshops were planned on the basis of data collected from the exploration phase of the project.

Qualitative research open up for *a holistic account* of the problem as the research progresses. This facilitates the researchers to build an understanding with the passage of time. Throughout this process, my understanding of value networks transformation has developed. This knowledge was coupled with the design of services based on remote diagnostics technology. Moreover, the knowledge was developed regarding value creation in the network while keeping customers' perception about value and needs in mind. The results from the initial findings together with literature studies directed the studies in later stages or phases of the research.

A qualitative research implies that data is collected from *multiple sources*. A detailed description of data collection is presented in the next section.

4.4 DATA COLLECTION AND ANALYSIS

As a part of the collaborative research project, I actively participated to collect data from different data sources such as project and service development meetings, workshops, and interviews. These activities included modeling value networks, designing digital services and developing business models to understand transformation of value networks in digital service innovation. Meetings notes from monthly project meetings and service development meetings were collected during the RDS project. A summary of the data sources with numbers is presented in the Table 4 below.

Type	Data Sources	Number of Activities
Meetings	Service development meetings	30
	Monthly project meetings	20
Interviews	Semi-structured interviews. The interviewee include representatives from GlobalAlpha; business area representatives from Alpha 1, Alpha 2 and Alpha 3; representatives TOCs; representative from PTA	28
Workshops	Workshops on modeling VN with business area representatives from Alpha 1, Alpha 2 and Alpha 3	3
	Service Design with representatives from TOC including business manager, service manager, drivers	1
	Business model workshops with representative from GlobalAlpha	2
	Business model workshop with project members	1
Documents	Project proposal	1
	Technical reports composed by technology developers and researchers	6
	Weekly project newsletters regarding project updates	53
	Meeting notes from project meetings	50
	Report on service development for miscellaneous management at GlobalAlpha	2
	Final project report written by all project members	1
	Email correspondences	---

Table 4: An overview of data sources

Each data sources in Table 4 were important to my understanding of transformation of value networks. Project meetings, interviews, and workshops were used as data sources together with documents. The following paragraphs provide details of the data collection activities and data analysis used in this thesis.

Project meetings run throughout the RDS project. Project meetings have been considered as an important source for data collection in IS research (Dennis and Garfield, 2003). In the same vein, project meetings were used as an important source for data in my study. The meetings in RDS can broadly be categorized into two distinct types as: (i) monthly project meetings that were used to raise issues and exchange knowledge both from technology and service development; and (ii) service development meetings that were used to address issues regarding the scope and design of services based on remote diagnostics technology as well as creating value out of these services. In line with the advice by Walsham (2006), initial meetings were focused on clarifying goals from the project; deciding on how to collaborate and roles of individuals in the project. These initial arrangements have been made both for monthly project meetings and service development meetings. A summary of

project meetings including both monthly and service development meetings is presented in Table 5 below.

The monthly project meetings were more diverse in nature than the service development meetings. In general, a monthly project meeting lasted between 2-3 hours. I together with other project members from technology development and service development took active part in these meetings. The meetings were aimed at sharing results and initiating discussion regarding issues in the project. During the meetings different participants presented problems within their relevant parts such as issues related to the development of remote diagnostics technology and services. For example, results and findings from interviews were presented to the meeting participants. Notes from the meetings were taken by different project participants at times and shared by the project manager with all the members. The purpose with sharing notes was to establish a common understanding of the meeting discussions. Since many project participants were from GlobalAlpha, these meetings were also useful in finding new references for the participants other than project members such as participants from TOCs.

Data Source: Project Meetings		
<i>Sub-source: Monthly Project Meetings</i>		
Participants	Activities	Data On
<ul style="list-style-type: none"> - Informatics researchers (3) - Technology researchers (3) - Project manager (1) - Technology developers (3) - GlobalAlpha service developers (2) 	Presentations of the technology and service developments; Discussions about technology development and service development such as customer needs and required services; Updates on technology and service developments including problems arose during the process	Descriptions on the role of remote diagnostics in value network; design of technology; capability of the digitized products; service innovation based on digitized products; incumbent behavior of GlobalAlpha in the value network; changing role of customers in the value network
<i>Sub-source: Service Development Meetings</i>		
<ul style="list-style-type: none"> - Informatics researchers (3) - GlobalAlpha service developers (2) 	Setting the goals for service development part; exploring customer needs; gaining insights about existing business of GlobalAlpha in different business including value propositions; Discussion on findings form interviews and workshops	An understanding of challenges and opportunities in the value network; service development in value network; incumbent behavior of GlobalAlpha

Table 5: Summary of project meetings

Service development meetings on the other hand were more focused towards exploring and designing service related to remote diagnostics. These meetings also discussed the issues such as designing value for these services. The meetings were continuously arranged on demand either by service developers in GlobalAlpha or informatics researchers. Discussions from monthly project meetings were used to inform and to provide input for service design meetings and vice versa. All project members have academic educations and in-depth knowledge in their respective fields. Therefore, I used concepts from the literature on value networks in my discussions with the participants. During these discussions, they provided insightful information about value creation based on remote diagnostics technology.

Interviews are considered as one of the primary data sources in an interpretive IS research (Schultze and Avital, 2011). In total, 28 interviews were conducted with different participants from various organizations. The interviews were designed as semi-structured interviews and each interview lasted between one to two hours. Following the advice by Schultze and Avital (2011), I remained open during the interviews and pursued follow-up questions on interesting issues. The purpose was to obtain information related to, for example, service value that an interviewee from a particular organization is interested in. For instance, when interviewees talked about the service opportunities with remote diagnostics technology, I asked how it could help to create value for their relevant organization. Further, the interviews were used to assess interpretations about digital technology on value networks from different participants. These interviewees were working at different levels in organizations such as manager, drivers, maintenance personnel. The interviewees represented the perceptions of different actors in the value network such as vehicle manufacturer, transport operating companies and public transport authority. This facilitated me to understand and differentiate between multiple perspectives of value networks which spans across different levels.

In addition, there was one interview with the project manager and one with service development manager to gain further insights about GlobalAlpha perspectives on the technology and services. Further interviews with technology developers from GlobalAlpha and technology researchers helped to the understandings about the technology. All interviews were recorded and later transcribed for further analysis. The interviews were guided by concepts from literature such as intangible exchanges as a source for value creation in a value network. To make understandable for the interviewees, empirical definition with examples were presented before the interview. This helped me as well as interviewees to share a common understanding about a particular concept.

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Initially, I found it bit difficult to conduct interviews, however I improved after following the advices by (Myers and Newman, 2007; Schultze and Avital, 2011). For example, I used guidelines by (Myers and Newman, 2007) to situate myself in the situation by describing my role, background, experience and clarified the purpose of the interview. However, I was aware of the artificiality of interviews (Myers and Newman, 2007) that could affect data collection regarding value network transformation. To minimize the effect of this artificiality as well as to avoid biases, I included representations of various “voices”. Other considerations that I attempted to follow during these interviews include minimizing social dissonance, providing flexibility and ensuring confidentiality of disclosures explicitly (Myers and Newman, 2007). A summary of these interviews with purpose and what kind of data they provide for this study is presented in Table 6 below.

Data Source: Interviews		
Interviewees	Aims	Data On
GlobalAlpha representatives such as technology developers and technology researchers	Aimed at gaining knowledge about remote diagnostics technology; limitations and advantages of the technology	An understanding about characteristics of remote diagnostics technology; Potential capability of the technology
GlobalAlpha maintenance manager, service developer, business manager, and project manager	Aimed at gaining access about current repair and maintenance operations; opportunities with RDS in existing operations; business opportunities with digital services	Insights about service exploration; service innovation based on remote diagnostics technology; understanding about role of GlobalAlpha in value network
Business area representatives from Alpha 1, 2, and 3	Aimed at gathering insights about existing value networks; New values with these services in value networks	Acquired an understanding about digital technology in value networks; description of potential value with service in a value network; role of vehicle manufacturers in relation to other actors in value network
TOCs representatives such as managers, repair and maintenance manager, bus drivers	Aimed at gaining insight about transport business including business operations; opportunities with remote diagnostics; customer role in value network	Descriptions on customer needs; customers perception on value; potential role of customers in value creation and in value network
PTA Manager	Aimed at understanding PTA’s role in the value network; value potential from remote diagnostics technology	Description about the role of a legal authority in the value network

Table 6: Summary of interviews

Workshops were used as capture how participants reasoned about opportunities and expectations regarding future use of the remote diagnostics technology. There were three kinds of workshops (i) value network modeling workshops for visualizing the existing value networks and the potential ones with remote diagnostics technology; (ii) service design workshops for conceptualizing the potential services based on remote diagnostics technology; and (iii) business model workshops for prototyping value creation and value proposition in relations to other actors in the perceived value network. In total, three value network modeling workshops were conducted as half-day activities separately with Alpha 1, 2 and 3. Different value networks were drawn with each of the business area managers from Alpha 1, 2 and 3 respectively. Service developers and a business manager from GlobalAlpha were also present during these workshops. These workshops served dual purposes: (a) to visualize the value networks of vehicle manufacturers with other actors for existing product business; and (b) to draw value networks showing potential value from remote diagnostics technology. Participants in these workshops were business managers with academic educations and professional experiences. Therefore, I presented an overview of value networks in each of the workshop, so that the participants could model the networks. In addition to existing business structure, these workshops reflect about the firm's rationale for conducting business.

Conceptualization of digital services was part of the service development in RDS project. To conceptualize the services explored during the exploration of the project, a service design workshop with B-TOC was conducted. The purpose of the workshop was to build design scenarios based on perceptions and needs of B-TOC. A presentation with examples was given to the workshop participants to give them idea how to build design scenarios. A design scenario is a visual representation of a particular service showing relation between different actors involved. The participants in the workshop were employed on different level with various roles within B-TOC such as business manager, service manager, and drivers. Hence, this workshop presented the customer's view on the digital technology being developed on different levels. The workshop participants were given free hand to draw whatever service they conceptualized from remote diagnostics technology. Later, the participants described the design scenarios and explained the rationale for drawing those scenarios. These descriptions were recorded and later a report was made on the basis of the recordings. The report was shared with the participants for confirmation and to share the result. The findings laid the basis for one of the business models prototype. The service design workshop represented the customer role as a co-creator or an active actor in the value network.

Finally, a business modeling workshop with project members from technology development part and two workshops with members from service development part were conducted.

These workshops were focused on developing business model prototypes with a reflection on how value can be created with various digital services conceptualized earlier. The purpose with business model workshops was to develop prototypes regarding various value propositions, customers segments, relationships with customers, resources, costs, and revenue models from the perspective of GlobalAlpha. For this purpose, business model canvass was used (Osterwalder and Pigneur, 2010). These workshops showed the changing roles of TOCs and GlobalAlpha together with relationships between them in a value network as well as new currency of exchanges. In the workshops, I had the opportunity to interact with participants in addition to observing and interpreting how the participants acted and talked about the digital technology. This facilitated me as a researcher to understand their contextually-grounded social experience. A summary of these workshops is presented in Table 7 below.

Data Source: Workshops		
Workshops	Activities	Data On
Value network workshops with business representatives from Alpha 1, 2, & 3	Modeling value networks to show different roles and relationships in the existing business; Identifying customers for RDS	Value networks representing existing product business of GlobalAlpha; role of focal actor and relationships with other actors in the value network; new currency of exchanges enabled by digital technology
Service design workshop with TOC representatives including manager, repair and maintenance personnel, drivers	Conceptualizing and designing services based on RDS; Use of these services in TOCs business operations	An overall understanding regarding customer business; changing role of customers in value creation
Business model workshop with project members from technology development part	Developing the prototype of value propositions for various services with the purpose of taking view of technology people	Descriptions about digital capability of technology;
Business model workshops with service developer from GlobalAlpha	Building prototype for various value propositions, customers segments, relationships with customers, resources, cost and revenue models from the perspective of GlobalAlpha	An understanding about technology's generative capacity

Table 7: Summary of workshops

Project documents were also used with other data sources and were used during data analysis. These documents include a project application, six technical report, fifty three

weekly newsletters, fifty project meetings notes, one internal report, and one final project report in addition to email correspondences. Weekly newsletters served the purpose of informing project participants about project issue and updates. A summary of the documentation is presented in Table 8 below:

Data Source: Project Documents		
Documentation name	Number of documents	Data On
Project Application	1	Description about the context in which value network is transforming
Technical reports	6	Descriptions about remote diagnostics technology including the approach to design the technology; Descriptions about characteristics of remote diagnostics technology
Weekly newsletter	53	A complementary knowledge regarding technology, services and related business
Final project report	1	Descriptions about findings from the project on value and value network
Service development reports	2	Description about potential value that can be created with digital services
Email correspondence	---	To gain complementary knowledge on project updates

Table 8: Summary of project documents

The above mentioned various data sources have been collected at different times during the project. On one hand, some of them run throughout the project durations on a regular basis such as project meetings and weekly newsletter, and email correspondences. On the other hand, some of the activities were spread over the project durations and were conducted as the need arose such as interviews. Finally, some data sources were collected by conducting activities at a specific period of time. For example, service design workshops were conducted after exploration phase of the project when initial input about services was obtained. Likewise, business model workshops were conducted after design scenarios as the result of service design workshops. A summary of these data sources along a time line along with research papers publications is presented in Figure 4 below:

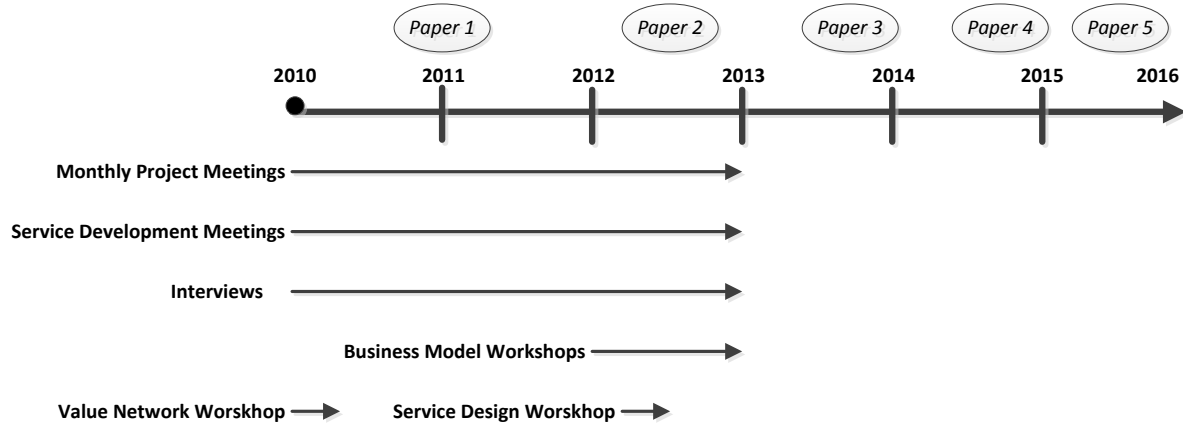


Figure 4: Data collection activities and papers

Data Analysis: The data collected from various data sources was analyzed using an overall interpretive approach. The approach to data analysis in this thesis follows the principles of hermeneutic interpretation (Walsham, 2006) to organized, interpret and present data. The nature of hermeneutic analysis promotes a holistic understanding of a phenomenon as it emerges over time. The understanding starts with some initial ideas about the parts of the phenomenon that are not well understood. In general, the analysis followed five steps in an iterative manner (see Figure 5 below).

Step 1 – The first step was to engage in a dialogue with the collected data by listening, transcribing, multiple and careful readings of transcriptions, notes and other documents. Further, many of data sources such as workshops, project meetings and service development meetings were summarized and paraphrased. Pre-analytical marginal remarks were used while engaging with the collected data such as on the side of interview transcripts. In addition, reflective notes were prepared from raw field notes throughout the process. This step guided the planning for the next contact in the field and data to be gathered.

Step 2 – The second step was to organize data on the basis of data source and the inquiry at hand as the research process proceeded. This was done by categorizing and sub-categorizing sources into interviews, workshops, meetings and documentation for all the participants. This organization of data facilitated in following different actors in the value network of manufacturing firm. Along the process of this study, data was re-organized for the purpose of each paper.

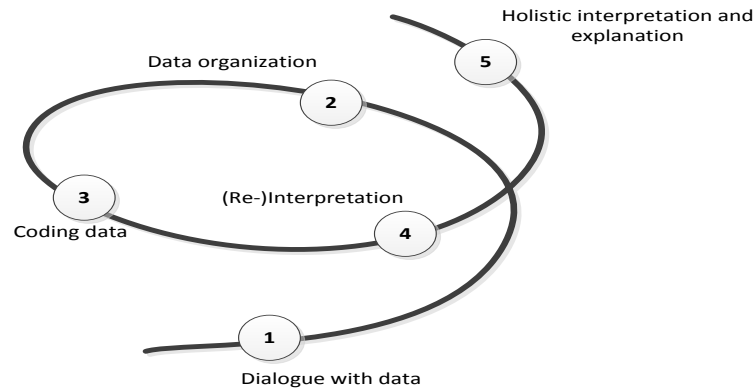


Figure 5: A simplified view of data analysis [adapted from (Thomsen, 2010)]

Step 3 – The third step was to code data from multiple sources into meaningful units. The coding was driven by the theory guided themes to interpret meanings. The coding was handled interpretively where interpretations of the data were made on the whole dataset. In the coding process, new themes also emerged from the data used in this research. The emergence of new themes was based on, for example, pre-analytical marginal notes. These new themes from the data were coded and applied to the whole dataset while re-examining previous coding, at the same time. In some hesitant cases, respondents were consulted about the adequacy of data interpretations. This re-examining of new themes with previous coding, reduced bias in the decision making while interpreting the whole.

Step 4 – The fourth step was to interpret what the coding revealed regarding the phenomenon of value network transformation. Selections of units of data were used to illustrate how interpretations are warranted by the empirical data with for example quotes. These coding were interpreted and re-interpreted in terms of roles, relationships and exchanges in value networks. The frames for interpretation developed over the ongoing review of literature, the research goals and emergent insights gained through interpretations. For example, the concept of role was used to understand how manufacturing firms and other actors participate in the networks. This was done by investigating the data that describes for example if the roles participate, how they change, and the position they take. Similarly, the interfirm ties were used to comprehend the evolving relationships between roles. Likewise, the concept of currency of exchange was used to understand the transactions between different actors in the industry, that is, what was being exchanged between different firms.

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The interpretations were made iteratively throughout the data analysis and some careful considerations were made. For example, as the RDS project was conducted in a collaborative way, many participants were involved in the project with their own individual practical and research interests. Some of data sources in this study covered wider perspectives than my research such as project documents and some of meetings with technological details. During the selection, the parts of data were chosen that were relevant to my research. During the interpretation, it was considered important not to strip the data at hand from the context of this research, that is, digital and service innovation in the vehicle industry.

Step 5 – In step five, the holistic interpretation and explanations were discussed and conceptualized as a model of value network transformation. These interpretations were made by finding out the common pattern in the data, comparing and contrasting the concepts from the literature, and getting input from project participants. All these activities were performed in iteratively with an increase in the understanding of the phenomenon.

Most of the individual papers are co-authored; therefore it is sensible to identify my own contribution to data collection and analysis in each of the piece. This has been summarized in Table 9 below:

Papers		My Contribution
Paper 1	Akram, A; Åkesson, M. (2011). “Value Network Transformation by Digital Service Innovation in the Vehicle Industry”. 15th Pacific Asia Conference on Information Systems, 7-11 July 2011, Australia	First author, mainly responsible for data collection and analysis
Paper 2	Chowdhury, S. and Akram, A; (2013). “Challenges and Opportunities related to Remote Diagnostics: An IT-based Resource Perspective”. International Journal of ICT and Human Development (IJICTHD), Vol. 5, Issue 3, July-September 2013.	Second author, equally responsible for data collection and analysis
Paper 3	Akram, A., Bergquist, M., & Akesson, M. (2014). Digital Visions vs. Product Practices: Understanding Tensions in Incumbent Manufacturing Firms. In System Sciences (HICSS), 2014 47th Hawaii International Conference on (pp. 4516-4525). IEEE.	First author, mainly responsible for data collection and analysis
Paper 4	Akram, A., (2013). The Influence of Generativity on Value Creation – A Study of Digitized Products. Accepted for IADIS International Conference on Information Systems, March, 2015, Madeira, Portugal	Single author, responsible for data collection and analysis
Paper 5	Akram, A., Akesson, M., & Bergquist, M. Generativity and control of digitized products – A study of digitized buses and remote diagnostics services	First author, mainly responsible for data collection and analysis

Table 9: Individual papers and my contribution

4.5 REFLECTIONS ON RESEARCH APPROACH

The hermeneutic circle is the fundamental principle for interpretative analysis (Klein and Myers, 1999). The circle suggests that new understanding of the whole is constructed from an understanding of individual parts and vice versa. This whole process works in an iterative manner and the together with interrelationships between the whole and the parts form the complete circle (Klein and Myers, 1999).

During an interpretive research, it is suggested to reflect upon the extent to which a research can be justified in the form of self-assessment. This self-assessment can take different forms (Klein and Myers, 1999; Walsham, 2006). I adopted the set of principles suggested by (Klein and Myers, 1999) to evaluate my interpretive research. These set of principles are listed in Table 10 below:

Principles for an interpretive field research	
1.	<i>The fundamental principle of the hermeneutic circle</i> This principle suggests that all human understanding is achieved by iterating between considering interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all other principles.
2.	<i>The principle of contextualization</i> Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.
3.	<i>The principle of interaction between the researchers and the subjects</i> Requires critical reflection on how the research materials (or “data”) were socially constructed through the interaction between the researchers and participants.
4.	<i>The principle of abstraction and generalization</i> Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.
5.	<i>The principle of dialogical reasoning</i> Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings (“the story which the data tell”) with subsequent cycles of revision.
6.	<i>The principle of multiple interpretations</i> Requires sensitivity to possible differences among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it.
7.	<i>The principle of suspicion</i> Requires sensitivity to possible “biases” and systematic “distortions” in the narratives collected from the participants.

Table 10: Summary of principles for interpretive research (Klein and Myers, 1999, p. 72)

Principle 1 is a meta-level principle that represents the fundamentals for human understanding. These fundamentals for human understanding are based on the principle of

hermeneutics circle. That is, in terms of building an understanding a research rests on iterations between the parts and the whole. In the same vein, the understanding of contributions was achieved through iterations between parts such as role of digitized products on value creation and the whole such as literature on value network. Likewise, writing individual papers represented parts while this cover paper represented the whole. Multiple iterations were made throughout the process to build the understanding

Principle 2 concerns the context of the research settings so that readers can understand the dynamics of the situation. Chapter 3 provided the research context in this thesis while research settings in individual papers provided the context of localized situations. The context of this research was influenced by two streams of innovations as digital innovation and service innovation in the vehicle industry. These two streams were presented as being integrated with traditional product innovation in the vehicle industry.

Principle 3 requires critical reflection on the interaction between the researcher and his subject. The research process for data sources in this thesis was designed in a way that two (or three) informatics researchers collected data in the field. Both the researchers had different research questions; however data collection activities were done together. This gave us the opportunity to continuously discuss and reflect upon our presence at the site and for data collection. Later discussions over the workplace allowed us to reflect upon the interpretations made by each of us. During the study, we found that firms in the vehicle industry are dominated by closed culture in daily practices. Moreover, many of the participants were from managerial positions with high concerns of secrecy of their ideas. This was further complicated as some participants were reluctant to express their experiences and thoughts. Since, the first phase of the RDS project was mostly about exploring the potential of remote diagnostics, it was utmost necessary to overcome this obstacle. For this purpose, first, we made it clear with every respondent before each activity that we already had signed the data protection contract with the firm. Second, we assured that this was only for research purpose and they would remain anonymous. Almost all participants were satisfied with these measures.

Finally, our understanding about the phenomenon developed over time. We found many similarities on approaching a particular topic. We also looked for various perspectives on the same topic to gather views of different roles (firms) in the value network. This also had motivated us to go for sampling for heterogeneity during data collection.

Principle 4 regards abstraction and generalization. This principle also highlights the importance of transparency to show readers how the generalizations have been made from the collected data. The individual papers in this thesis described these details how theoretical elaborations have been made. To make this process transparent, for instance, I

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used quotes from individual participants while making them anonymous at the same time. Further, depending upon the focus of each study in the individual paper, different theories had informed the general conclusions. Finally, the understanding between the parts and whole as suggested by hermeneutic circle helped me to make generalization in the cover paper of this study.

Principle 5 focused on the contradictions between the theoretical preconceptions guiding the research design and actual findings. The collection of data can be misled by guiding themes found in the literature. This can further be complicated by prior beliefs, assumptions, values and interest. Being in close geographical proximity, we (other informatics researchers and me) used to have continuous discussions and helped each other in clarifying topics. We also discussed our findings and interpretations from individual papers on regular basis that helped us to avoid such contradictions.

Principle 6 emphasize on multiple interpretations, which requires a researcher to look for multiple view points and reasons behind them. To explore the remote diagnostic services and its influence on value creation, we collected data from personnel at different positions within the same organization. For example, in order to collect customer needs from TOC, we conducted managers, assistant manager, repair personnel and bus drivers. We also seek out for multiple view points by collecting data from same position such as manager but in different organizations. This gave us idea about conflicting views while approaching the same topic.

Principle 7 is related to the being suspicious and be sensitive to “biases” and systematic “distortions” in the data collected from the participants. This requires a researcher to ‘read’ between the social lines, that is, reading the social world behind this. We combined views from different business areas to compare and contrast the data.

5. RESEARCH CONTRIBUTIONS

This thesis builds on a collection of three conference paper, one published journal article and one submitted journal article. All of these papers and articles are peer reviewed by the international community. Based on these papers and the empirical material, the cover paper builds contributions into a coherent and relevant perspective of value networks in digital service innovation. The outline of the section is as follows:

The next section summarizes each of the individual papers included in this thesis. The summaries reflect how these papers provide input to overall contribution of the study. In the following section, I discuss how digital service innovation transforms roles, relationships and exchanges in value networks. Finally, I provide the implication for research and practice followed by direction for future study.

5.1 SUMMARY OF RESEARCH PAPERS

This section provides a brief summary of each individual paper that contributes to the overall understanding of the phenomenon. All the papers are linked to the main research question and report the findings from the project. These findings are then supported with the existing theoretical background in the field.

Paper 1 – Model to Study the Transformation of Value Networks

The first paper presents a concept driven model to study the transformation of value networks in digital service innovation. Based on the literature about value network in digital innovation, the study emphasizes that vehicle industry like other manufacturing industries has great potential to expand its business in the service sector. In doing so, traditional fixed business boundaries of the firms in the industry are breaking apart and new boundaries with flexible business horizons are emerging in the digital age. In this digital era, value networks as the spaces for creating value are transforming as the result of digital capability provided by technology. That is, new information models are imitating that will incorporate service oriented part of the business. Again this backdrop, the existing roles and relationships in value networks are transforming from product oriented to solution oriented value networks. During the change some new roles emerge while older roles either fade away or transform into completely different ones. The study further proposes that digital technology enables new kind of currency exchanges in a value network. These new currency of exchanges are enabled by the capabilities provided by digital technology. During the transformation, currency of exchange is not only about economic transactions. Rather intangible currencies of exchanges exceeds from brand recognition and customer loyalty to sense of community, knowledge exchange and many more. These intangibles are

influencing the relationships with other stakeholders during the design of new digital services. Therefore, value networks in digital service innovation become more dynamic than traditional product oriented value networks. This study proposes that studying the changes in roles and relationships as in a value network are important constituents and require considerations of IS researchers. Therefore, studying the transformation of roles, relationship, and currency of exchange as constituents are important to build an understanding about the influence of digital service innovation on the transformation of value network.

Akram, A; Åkesson, M. (2011). "Value Network Transformation by Digital Service Innovation in the Vehicle Industry". 15th Pacific Asia Conference on Information Systems, 7-11 July 2011, Australia.

Paper 2 – Challenges and Opportunities related to remote diagnostics

This paper investigates the business challenges and opportunities as the digital capability of remote diagnostics is challenging the exiting sociotechnical structures. This study draws conclusions focusing on an incumbent manufacturing firm as a focal actor within the vehicle industry. The results demonstrate that innovation in digital technology enables incumbent manufacturing firms to create imitable resources that can be used to harness value creation in a network. However, these opportunities come along with various types of challenges. The findings present challenges and opportunities for physical IT infrastructure, human IT resources, and IT-enabled intangibles as a part of an adoptive IT-based resource perspective. In a sociotechnical environment of value network, building a distributed digital infrastructure is challenging due to lack of compatibility of diverse digital resource. This may influence the roles of actors such as customers in the value creation process. Design and provision of standardized services was another issue as each of the digitized products behaves differently. Furthermore, IT-enabled intangibles require customer orientation based on actual customer needs rather than perceived by the focal firm. On the other hand, incumbent manufacturing firms can share assets, resources, and knowledge with other actors to create inimitable capabilities in order to expand their supplementary resources as new sources of value. Digital resources in the mix could be in many forms such as functionality or embedded knowledge that is brought to the relationship; or a digital platform that offers value through greater access to resources and expands functionality. Especially, building synergy through IT-enabled resources can open new avenues for value creation in the value network. However, using knowledge as an asset for new currency of exchange can be challenging due to existing business practices. The opportunities to create new value and challenges posted by existing or lack of structures influence how value networks are re-shaped.

Chowdhury, S. and Akram, A; (2013). “Challenges and Opportunities related to Remote Diagnostics: An IT-based Resource Perspective”. *International Journal of ICT and Human Development (IJICTHD)*, Vol. 5, Issue 3, July-September 2013.

Paper 3 – Tensions in Digital visions vs. product practices

This study provides insight into social-technical tensions that emerge as the design of digital technology progresses in the value network within the vehicle industry. This study argues that these tensions emerge due to difference in incumbent manufacturing firms’ vision and existing business practices. While the firms envision exploring new areas of service business based on digital service innovation, the dominant logic of excelling in product business is creating tensions during the process of innovation. This dominant logic is based on the cognitive simplifications, operant conditioning and cognitive biases of management. The choices made by management influence the strategic position of a focal actor in the value network. This The study found tension between design and development of digital technology; control an collaboration with customers; emerging requirement and existing work practices; and inertia in evolving value network. These shearing forces are challenging the dynamics of transformation in value networks.

Akram, A., Bergquist, M., & Akesson, M. (2014). “Digital Visions vs. Product Practices: Understanding Tensions in Incumbent Manufacturing Firms”. *47th Hawaii International Conference on System Sciences (HICSS) 2014*. (pp. 4516-4525). IEEE.

Paper 4- Value Creation in Digital Service innovation

This paper discusses the how generativity of socio-technical structures in a value network have the potential for innovative values. The study uses the notions of generativity to explain the value creation in digital service innovation along technological and social dimensions. Along these dimensions, the concept of generativity is associated with the capability of a digital technology (i.e. remote diagnostics) and social actors, respectively. The findings present three distinct and potentially parallel value systems as the result of the generativity. Along the technological dimension, the generativity of digital technology informs new values for actors in a value network with the help of flexible design of the technology. Along the social dimension, the context of vehicle industry provides input where digital technology is developed. Within this context, the firms holding influential positions such as incumbent manufacturing firm in the vehicle industry plays an important role in building and managing relationships with other actors in the network. The possibility to develop multiple value systems is further harnessed by sharing resources with other actors to create value in a value network. These resources are enabled by digital technology and bring about new currency of exchanges. Examples of currency of exchange in the vehicle industry include product knowledge, customer needs, sense of market, and

customer loyalty. As a result of the design of digital technology infrastructure, effective management of resources and shared form of governance in a network leads to the opportunity to build multiple and parallel value systems.

Akram, A., (2015). “The Influence of Generativity on Value Creation – A Study of Digitized Products”. 8th IADIS International Conference on Information Systems, March, 2015, Madeira, Portugal. IADIS Press

Paper 5 – Balancing Generativity and Control of Digitized Products

Digital innovation changes the relationship between actors’ roles in value networks. This transformation has mainly been studied in situations where content is decoupled from the device through digitalization, in which generativity can be harnessed to drive innovation. However, many digital innovation processes are characterized by digital innovation where digital service content is deeply entwined with the actual use of the device. This leads to different practices shaped by the coupled relationship between hardware and service layers and where generativity is dependent on the actual use of a particular hardware which binds the possibilities to innovate services to the actual control of data generated by use. In this research we highlight how such symbiotic relationship between a digitized product and service innovation affects the role of a focal actor – a manufacturing firm – in a value network. We studied a case in the vehicle industry where embedded sensors generated data based on actual operation of the vehicle used for designing remote diagnostic services. The research identifies how the incumbent firm, the manufacturer of the vehicle, involved in the value network balanced generativity and control to take command of control positions in the network. We conclude that such strategy that might seem successful actually can hamper innovation between actors in the value network due to decreased ability for other actors to co-create value.

Akram, A., Akesson, M., & Bergquist, M. “Balancing Generativity and Control of Digitized Products – A Study of Digitized Buses and Remote Diagnostic Services”. Submitted to an international Journal

The following table summarizes the contribution from individual papers included in this thesis:

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	1	2	3	4	5
Title	Value Network Transformation by Digital Service Innovation in the Vehicle Industry	Challenges and Opportunities related to Remote Diagnostics: An IT-based Resource Perspective	Digital Visions vs. Product Practices: Understanding Tensions in Incumbent Manufacturing Firms	The Influence of Generativity on Value Creation – A Study of Digitized Products	Balancing Generativity and Control of Digitized Products
Question	How are existing value networks in product oriented business transformed by digital service innovation?	What are the business challenges and opportunities related to remote diagnostics?	<i>What are the tensions for incumbent manufacturing firms when innovating their business with digital services?</i>	<i>How does generative capacity influence value creation of services of digitized products?</i>	How do manufacturing firms leverage value of digitized products of balancing generativity and control?
Motivation	To understand the influence of digital service on existing value networks	Relative less IS research on understanding business challenges and opportunities of a new technology during the development phase	Tensions emerge when product innovation regime is combined with IT innovation regime. However, less is known about how existing product practices influence achieving new visions in digital innovation	Generativity is a new source of value creation. However, less is known about how it is developed in the networked business environment	Generativity is a source for new value. There is need for more research in IS how it is shaped with digitized products
Literature / Theory	Value network, Digital Innovation, Digital Service Innovation	IT-enabled Resource (IT Infrastructure, Human IT-resources, IT-based resources)	Dominant Logic (Cognitive simplification, Operant conditioning, cognitive bias)	Generativity	Generativity, control, value network
Empirical Material	Interviews, Meeting Notes, Value Network workshops, Project Documentation	Interviews, Meeting notes, value network design workshops, weekly project reports, mail correspondence	Interviews, Meeting notes, weekly project reports, value network workshops	Interviews, Meeting notes, service design workshops, value network workshops, project reports, weekly project reports	Interviews, Meeting notes, service design workshops, value network workshops, project reports, weekly project reports

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Contribution	Provided a conceptual framework to study the transformation of value networks in digital service innovation	Business challenges and opportunities associated with digitally enabled resources	The dominant logic of product oriented business is creating tensions to incorporate service business	Generativity enables value-in-design, value-in-networking and value-in-governance; Digital technology provides an integral view on value creation	Control of device layer has implications for value creation on the service layer due to symbiotic relationship between digitized product and digital services
Reflection	Digital technology is triggering the transformation of value network of incumbent manufacturing firms in the vehicle industry	While digital technology enables new currency of exchanges, realizing intangibles as a source for value creation is challenging for existing value network	Assumptions about stable value creations structures may limit the exploitation of value digital innovation	Value creation is shaped by not only generative capacity of the technology but also firms business context in which they operate	In the vehicle industry, the service value is influenced by control at product use
Role in thesis	The paper lays foundations with the help of concept driven framework to study the transformation of value networks in digital service innovation	The challenges and opportunities emphasize the need to address new currency of exchanges in a value network	This paper provides the illustration that social and technical structures during digital service innovation contains inherent tensions	Generativity requires firms to operate in multiple directions and in parallel to create value in network	The symbiotic relationship enable firms to enact control at different layers which may hamper value creation in a value network

Table 11: Summary of research papers

The research papers presented in this thesis provide insights to the understanding of the influence on value networks transformation in digital service innovation. In this thesis, the main question addressed in this thesis is: *How are value networks of manufacturing firms transformed in digital service innovation?* First, this thesis provides an empirical account of value network transformation in the vehicle industry. Then, this thesis contributes to the understanding of the transformation of value networks by (i) describing the emergence of the pattern of value creation in digital service innovation enabled by digitized products; and (ii) discussing the influences on roles, relationships and exchanges in value networks. Finally, this thesis concludes the discussion by presenting implications for theory and practice followed by limitations and directions for future research.

5.2 AN EMPIRICAL ACCOUNT ON VALUE NETWORK TRANSFORMATION IN THE VEHICLE INDUSTRY

This thesis provides an example of how a digital service innovation in the vehicle industry extends the boundaries of an established product oriented business firm (i.e. GlobalAlpha) by including digital services. The analysis of data reflects that traditional product oriented value network of GlobalAlpha is being replaced by solution oriented value network. The product oriented value network consist of pre-defined roles such as GlobalAlpha as seller or producer, TOCs as customers or buyers, dealers as the middle man for selling vehicles to small companies, and independent third-party physical parts producers. These product oriented value networks do not consider, for example TOCs, important in value creation. Furthermore, views from PTAs and public commuters are not included during the creation of value. This means that value is created in-house with any intervention or collaboration from the direct or indirect customers of GlobalAlpha. However, with digitized buses GlobalAlpha designed digital service to create value in an innovative way. With the digital and service innovation in the vehicle industry, the value is created in a networked environment. In this networked environment, GlobalAlpha and TOCs are working collaboratively and considering inputs of others such as PTA, to create value. This has been observed in value networks of GlobalAlpha in this thesis.

When GlobalAlpha started to digitize vehicles by embedding digital technology a new innovation journey started. The digitized products enabled new opportunities to explore and innovative digital services such as services related to maintenance of vehicles. An example of such services related to maintenance of vehicles includes ‘diagnosis of errors’ remotely. To diagnose the errors, following information resources are needed: on-board diagnostics information when vehicle is one the road, vehicle service history, back office analytical tool, and product knowledge of the vehicles. The design of these services is dependent on the use of the vehicles. For example, if a vehicle is in the garage, the remote diagnostics technology cannot collect data about the usage of different parts of the vehicle. Hence, no diagnostic service can be designed in the absence of the information about the vehicle. It is also worth noting that the information related to a particular vehicle is not relevant to another vehicle. However, on one hand, the information is generated from the vehicle is owned by Public transport companies (TOCs) and critical for diagnostics services. On the other hand, GlobalAlpha owns the product (i.e. vehicle) design knowledge and patented algorithms at back-office as well as on-board on vehicles. Service history, however, can be owned by either TOCs or by GlobalAlpha. Furthermore, TOCs are bound by transport service contracts they sign with public transport authorities.

Since the vehicle and related maintenance services are bound together, different firms (e.g. GlobalAlpha, TOCs, and PTA) collaborate with each other to design and create value from

the services. TOCs, for example, share the on-board information with GlobalAlpha who uses product design knowledge, back-office analytical tools, and service history to come up with diagnostics information services. For this purpose, both firms are involved in sharing information about the vehicle to design the services. However, GlobalAlpha has the advantage of owning difficult to imitate resources, such as patented algorithms, vehicle design knowledge and in some cases service history. Therefore, GlobalAlpha try to acquire the position where all TOCs are dependent on it even if they design the services by themselves. GlobalAlpha is further controlling the process by making these services available only for their brands. However, TOCs also own the on-board information and in some cases service history. TOCs are also source of knowledge about the market needs for services. This forces GlobalAlpha to include TOCs in the design of service. In addition, Public travelers are the main customers of TOCs and of great importance for PTA. Their experiences regarding smooth journey make them relevant in the value network. Furthermore, to design services in real world settings, GlobalAlpha and TOCs are continuous interacting with each other. This involvement of TOCs in service design by building deep ties and sharing lot of information is changing value networks of manufacturing firms. This way GlobalAlpha is including more firms in creating value from design of the services. Under these circumstances, the value network of GlobalAlpha is expanding from and in-house product oriented to a networked one by including other companies in the network.

5.3 VALUE CREATION PATTERN IN VALUE NETWORKS OF DIGITIZED PRODUCTS

Digitized products are challenging the value creation in value networks of manufacturing firms. This thesis shows that there is a symbiotic value relationship between the digitized products and digital services, here conceptualized as product-service symbiosis (Paper 5). This product-service symbiosis is provided by the generativity of digitized products and digital services. In terms of value, the product-service symbiosis expands the traditional value-in-exchange associated with product oriented value network with value-in-use associated with service value network (Lusch and Nambisan, 2015), and brings about usage driven value of digitized products and services (Paper 3; 4). The product-service symbiosis implies that use of digitized products and services use are mutual and inter-dependent. This means that digital services are designed and used in connection with the use of digitized products (Paper 5). This mutual and inter-dependent relation generates digitally enabled resources such as real-time usage patterns of digitized products. These digital enabled resources are specifically digital intangibles (Paper 2). These digital intangibles are combined and recombined with other digital and non-digital resources in the infrastructure of the digitized products. The combination and re-combination of digital and non-digital resources is done through mix-and-match (Yoo et al., 2010) where different firms can participate in the innovation process (Paper 3; 4). The use of new digital services together with digitized

products provides input for the generation of further digital resources forming a value creation pattern.

Value creation pattern in this thesis refers to the repeated and regular way value is created. For example, in the RDS project, the use of digitized vehicles and related services such as remote diagnostics services are in symbiosis. The digitization of the buses provided an opportunity to the vehicle manufacturer to design services related to the vehicles. While the digitized buses were in traffic, the manufacturer could gather information about the performance of a particular bus from a fleet in the form of usage patterns. The information generated from the use of vehicles was combined with other resources such as service history database and analytical algorithms to draw conclusion about the health of different parts of the vehicle. On the basis of these conclusions, new diagnostics services were designed for customers. These diagnostics services are of prime value, for example, for TOCS to repair and maintain the vehicles. The use of these digital services together with product-service symbiosis generates new resources and designing services from these resourcing by re-combination. In this way, the value creation pattern is repeated in an iterative manner and brings value for different roles in the value network. In conclusion, while value creation in digital service innovation emphasize on value-in-use (Lusch and Nambisan, 2015), this thesis emphasizes on the ‘usage driven value’ together with value-in-exchange and value-in-use in the network. The pattern of value creation influences the roles, relationships and currency of exchange in the value network of manufacturing firms as shown in the Figure 6 below:

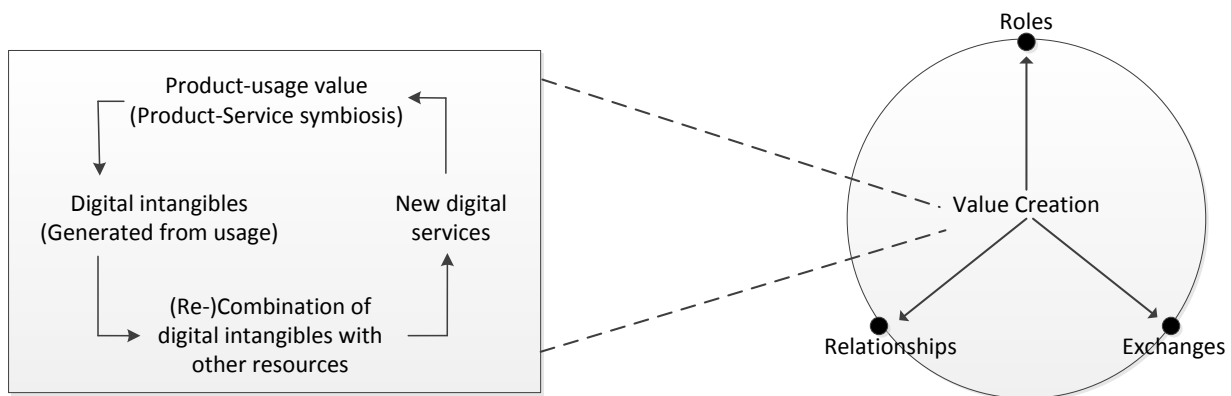


Figure 6: Value creation pattern in value networks of digitized products

As illustrated in Figure 6, the value creation pattern is at the core of the value network. The next sections provide details on how the pattern of digital service innovation transforms roles, relationships and currencies of exchange in the value network of manufacturing firms.

The contributions are guided by reference from the literature and the finding from the individual papers included in this thesis.

5.4 INFLUENCE OF VALUE CREATION PATTERN ON VALUE NETWORKS

This study illustrates how digital service innovation and the value creation pattern of digitized products transforms the roles, relationships and currencies of exchange in the value networks of manufacturing firms.

5.4.1 DYNAMIC ROLES

Digital service innovation influences the roles in the value networks of incumbent manufacturing firms as the roles may remain dynamic rather than evolving to an end-state (Vaast et al., 2013). This means that roles remain fluid instead of having a predefined and fixed form (Paper 1; 4). In digital service innovation, the use of the digitalized products enables manufacturers to generate new digital resources such as the real-time usage patterns of the digitized products. However, other resources may be controlled by other roles in the network. For example, in the case of RDS, resources such as service history records required to design diagnostics services are in the control of customers (i.e. TOCs). Therefore, manufacturing firms collaborate with customers who own complementary digital resources required to design digital services. This changes the role of customers from being passive value receivers or consumers to a dual role of value co-creators and consumers at the same time. Likewise, the role of an intermediary such as a legal authority may emerge as a potential customer for manufacturing firms. Similarly, the manufacturing firms in the value network may take the role of problem solver or solution provider rather than product seller and co-create value with other roles (Paper 4; 5). Finally, the usage pattern of the digitized product is linked to many other aspects such as, in the case of vehicles, physical transport infrastructure and road as well as weather conditions. These circumstances lead to participation of different roles to create value in the network of digitized products. This participation of different roles is an important source for value creation in value networks (Yoo et al., 2010).

However, this participation is influenced by the innovation strategies of individual roles who tries to adopt a specific position in a value network (Pagani, 2013). For example, manufacturing firms attempt to take leverage of product-service symbiosis between product use and design of new services as they have the control over the specialized resources. An example of such specialized resources is the design knowledge of digitized products (Hylving et al., 2012). This knowledge is critical to design new digital services. Thereby, manufacturing firms attempt to take a focal position by enacting control at the physical layer in the co-creation of digital services. The role of customers as co-creators in this case is limited in terms of control over the co-creation of new digital services (Paper 5).

Manufacturing firms may further enact control in a value network by minimizing the role of intermediaries such as third-party developers in the design of the services (Paper 5). In conclusion, the usage driven value creation pattern makes roles dynamic in the network of manufacturing firms. The usage value may motivate these roles to participate (Paper 3) and to acquire the control position (Paper 5) in the value networks.

5.4.2 EVOLVING RELATIONSHIPS

Relationships in value networks vary, especially in innovation related to knowledge intensive services (Simard and West, 2006). In digital service innovation of digitized products, traditional formal relationships are transformed into informal relationships (Paper 4; 5). Likewise, wide relationships among various roles are transformed to deep ones through continuous interactions between roles (Paper 4). The value creation pattern in the value networks of digitized products transforms the relationships, as illustrated in Figure 6, to build informal and deep ties. Given the product-service symbiosis (i.e. symbiotic value relationship between digitized products and digital services), the generation of digital resources is dependent on the presence of deep relationships between roles. For example, the generation of usage pattern is possible if manufacturing firms and their customers have deep ties. The customers may continuously exchange the digital resources such as vehicle usage information for quality of service provision. The sharing of information results from the continuous interaction between technical as well as between technical and human elements of the digital infrastructure (Paper 2). Likewise, the formal relationships between roles in the value network of manufacturing firms are transformed to informal ones as a result of continuous interactions (paper 4). As a result of continuous interactions among technical and social structures, the relationships in a network are defined and re-defined constantly. This leads to evolving nature of relationships between roles in a network. Furthermore, this transformation holds both for direct as well as for inter-relationships between roles in a network. An example from the study in this thesis is the direct relationship between manufacturing firms and customers, and inter-relationship between manufacturing firms and intermediaries (Paper 5).

In summary, the relationships in the value network of manufacturing firms transform from formal and wide to informal and deep through continuous interactions between roles. These continuous interactions, in turn, lead to the evolving nature of relationships in the value network. While relationships are an important source for value creation (Peppard and Rylander, 2006), the value creation pattern urges for continuous interactions between roles for developing informal and deep relationships. In turn, the continuous interactions constantly define and redefine these relationships that provide input for evolving relationships in a network.

5.4.3 MUTUAL AND INTERDEPENDENT EXCHANGES

While digital service innovation brings new kinds of exchanges (Basole and Rouse, 2008; Rai and Sambamurthy, 2006), there is an emphasis on including intangibles in addition to tangibles as currency of exchange (Lusch and Nambisan, 2015; Lusch et al., 2010). In value networks, value creation is not restricted to economic transactions rather exchange of digital-enabled intangibles are equally important (Paper 1). This thesis posits that the value creation pattern of digitized products and services plays an important role in highlighting the increasing role of intangibles as new currency of exchange. Given the product-service symbiosis in digitized products (Paper 5), the value creation pattern offers unique digital resources such as information about the usage patterns of digitized products as a new currency of exchange. However, in order to design new digital services based on customer needs, synergy among roles in the value networks of manufacturing firms is required. This synergy can be achieved by establishing new communication channels (paper 2; 3). The exchange of knowledge enables other actors such as customers to take the role of co-creator in the value network of incumbent manufacturing firms. Furthermore, in order to co-create value, manufacturing firms are required to make changes to the existing process and policies with other roles in the network. This is in line with the recent observations made by Lusch and Nambisan (2015) regarding exchange in digital service innovation. An example of such change is considering intangibles as a currency of exchange while dealing with customer orientation to design new services (paper 3; 4). Therefore, the currency of exchanges where the importance of intangibles is increasing (Allee, 2008) is influenced by mutual and interdependent value for multiple roles in a value network.

5.4.4 SUMMARY

In summary, the research in this thesis shows that value networks of manufacturing firms are transformed by digital service innovation. An emergent pattern of value creation has been described. This emergent pattern of value creation is grounded in product-service symbiosis where symbiotic value relationship exists between digitized products and digital services. This product-service symbiosis gives rise to usage value of digitized products in the value networks of manufacturing firms.

The generativity of digitized products prompts sociotechnical structures to transform value networks of manufacturing firms. This generativity begins to challenge the existing sociotechnical structures of value networks by providing new opportunities and challenges in an evolving space. In turn, these challenge the positioning of roles and the existing relationships between these roles. The sociotechnical space also provides opportunities for value creation by offering new currency of exchange in a value network. However, value that is created in value network as the result of dynamic interplay within sociotechnical structures of value networks. Thus, value networks of manufacturing firms are transformed

by the value creation pattern based on symbiotic value relationships between digitized products and digital services.

The value creation pattern transforms roles, relationships and currency of exchange in the value networks of manufacturing firms as follows. First, the roles shows dynamic nature that attempt to acquire different strategic control positions through continuous interactions where usage knowledge serve as a new currency of exchange. Second, the relationships are evolving as the roles remain fluid where knowledge about usage of digitized products emerges as a new currency of exchange. Finally, the currency of exchange between roles to establish informal and deep relationships is based on mutual and interdependent exchanges in a value network. This emphasizes the complex and evolving nature of value networks of manufacturing firms instigated by digital service innovation. Therefore, there is a need for understanding the transformation of value networks. The model presented in this section is an attempt to provide an understanding of the transformation of value networks of manufacturing firms. This understanding has implications for theory and practice in digital service innovation.

6. CONCLUSIONS

This thesis contributes to an understanding of value networks in digital services innovation. The individual papers followed by this cover paper present findings from the parts while the findings in cover paper reflect the whole. These findings have implications both for research and practice and are described in the sub-sections below.

6.1 IMPLICATIONS FOR RESEARCH

This thesis aims to contribute to the research on digital service innovation in the IS field by focusing on the business aspect. This thesis posits that the transformation of value networks is characterized by value creation pattern in digitized products. By highlighting the importance of usage value in digitized products, this thesis contributes to the literature on value networks (see e.g. Allee, 2008; Lusch et al., 2010; Peppard and Rylander, 2006) in digital innovation (see e.g. Henfridsson and Bygstad, 2013; Yoo, 2013; Yoo et al., 2010) and service aspects of IS (see e.g. Barrett et al., 2015; Lusch and Nambisan, 2015).

Rather than taking the perspective of digital services as independent of the physical architecture of products (Yoo et al., 2010), this thesis conceptualizes value creation on the notion that there is a symbiotic value relationship between digitized products and digital services. This means that use of digitized product and services are mutually dependent on each other for successful digital service innovation. This inter-dependence defines what kind of digital services are designed and they are used. Consideration of this symbiotic value relationship is crucial for investigating the success of innovation of digital services based on digitized products. This, otherwise, may limit the view on value creation in value networks of manufacturing firms.

Moreover, due to the influence of products digitization on value creation (Lyytinen and Yoo, 2002), there is a need for more research on value creation in technology embedded settings (Barrett et al., 2015; Yoo, 2013). This thesis addresses this call on research by presenting the value creation pattern in value networks of digitized products. The value creation in digitized products is specified by the tight coupling given by product-service symbiosis. This symbiotic value relationship extends the value-in-use in digital-service innovation (Lusch and Nambisan, 2015) by usage value brought by product-service symbiosis. The analysis of the value of digitized products, not taking this symbiotic relationship into account, risks missing out an integral aspect of value creation.

While roles remain dynamic in digital innovation (Vaast et al., 2013), this thesis advances the knowledge on control dynamics of roles influenced by product-service symbiosis. As the result of usage value in value creation, different roles control new resources and become co-

creator of value in the design of new digital services. Furthermore, this enacting control facilitates roles to obtain the strategic position of a focal firm in the value network. As a result, the value creation pattern motivates different roles to participate. Such participation of roles in value creation is recognized as a key source for value creation (Barrett et al., 2015; Lusch and Nambisan, 2015; Peppard and Rylander, 2006). This gives rise to value-in-networking based on usage value. Understanding the strategic control positioning leveraged by product-service symbiosis is important for understanding role dynamics in a particular value network.

While the traditional currency of exchange is dominated by tangible transactions (Nevo and Wade, 2011; Nevo and Wade, 2010), this thesis acknowledges the importance of digital intangibles as new currency of exchange in digital service innovation. This requires more flexible and adaptive value network structure in digital service innovation (Lusch et al., 2010). This thesis suggests that value creation pattern endorses intangible currency of exchange by generating unique intangible digital resources. The value of these unique and difficult to imitate resources is based on mutual and interdependent exchanges between roles. However, these mutual and interdependent exchanges are worthless in the absence of continuous interactions between different roles in a value network. This is in line with the existing research that has asked to shift focus from intangibles and include tangibles as viable currency of exchange in digital service innovation (Allee, 2008; Lusch and Nambisan, 2015). Finally, not dealing with digital intangibles as a new currency of exchange may lead to erroneous investigation of the value of digitized products. Therefore, the inclusion of digital intangibles as a currency of exchange can be decisive to in investigating new value creation in digital service innovation.

While previous research suggests that value creation is facilitated by building various kinds of relationships (Simard and West, 2006), this thesis put forward that continuous interaction between different sociotechnical elements facilitates building informal and deep ties. While relationships are key source for value creation in a network (Peppard and Rylander, 2006), understanding the influence of value creation pattern in building these relationships is important to examine the value of digitized products.

On a whole, this thesis posits the value creation pattern of digitized products and services makes value network dynamic which change constantly by digital service innovation. This is in contrast to traditional value chains which change only with the emergence of challenges to value creation (Peppard and Rylander, 2006). This thesis put forward that the value networks of manufacturing firms show dynamic and evolving nature with more horizontal value creation structures in the digital era. In the last, by presenting the value creation

pattern and its influence on value networks, this thesis advances the knowledge in IS on business aspects of digital service innovation.

6.2 IMPLICATIONS FOR PRACTICE

Based on the knowledge gained during this study, some specific suggestion can be given. These suggestions can serve as guidance for manufacturing firms especially in the vehicle industry who are on their way to provide solution oriented business. On a general level, the firms need to develop solution or even service -oriented approach in the changing business environment. The firms also need to think about the value of the product throughout its life-cycle cost rather than just one time value from the sale of the product. In addition to these general level suggestions, there are few more specific as described in the later part of this section.

The value creation pattern emphasizes on a tight bound between the use of products and the design as well as use of digital services. It also depicts the control on different kinds of resources by others firms. These resources are necessary for designing services related to the vehicle industry. The value creation pattern may help manufacturing firms to recognize the importance of other firms in value creation creating value in a networked environment. This, in turn, changes not only the perception about the direct customers but also other firms for value creation based on remote diagnostics technology. This understanding may also lead to changing the strategic position of not only manufacturing firms but also other firms in the networked environment. First, the value creating pattern suggests that manufacturing firms are re-establishing their relationships with customers. The re-establishment of these relationships is done through the participation of different firms in a networked environment. Second, to reap the economic benefits by providing services, firms need to explore new currencies of exchanges. In the existing business approach, the firms mostly think about economic exchanges and there are few non-economic exchanges. To develop service based on intensive knowledge, firms ought to find new currency of exchanges, for example, to convert intangible assets into economic ones. For this purpose, the firms are required to build new relationships with their customers that are missing in today's environment. Finally, to create value from these services, there is a need to shift from centralized control over value creation to a shared one by participating in a networked environment. This new culture of innovation can still be practiced by partially opening up for other firms in order to create value. In this regard, incumbent manufacturing firms will benefit from advantages offered by value co-creation in the network.

6.3 LIMITATIONS AND FUTURE RESEARCH

The contributions and implications in the previous sections are bound by the research aim, guiding literature and research method in this thesis. There are naturally limitations in this study that can be addressed in the future.

First, this study has used qualitative method for the empirical investigations. The qualitative method has facilitated the generation of rich insights about transformation of value networks by digital service innovation. However, the approach has its own limitations in terms of generalizations of the result using statistical techniques. For this purpose, different quantitative methods can be used to generalize the findings. Second, the rich insights have been studied in the vehicle industry where manufacturers envision expanding their existing product business with services. Future work is needed to elaborate on the findings presented in this thesis. This can be done, for example, by conducting the research in other industries. This can facilitate the generalization for research on value networks in other contexts where digital service innovation takes place. Third, digital service innovation in general is nascence and emerging discourse of research. Therefore, there is possibility for missing some issues and challenges associated with the phenomenon understandings. Finally, the contributions reflect the value network from a focal firm's perspective. A network level analysis can elaborate the findings presented in this thesis. Despite of all the limitations, the study provides tangible contributions where digital service innovation has important role in the ongoing transformation of value networks.

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