Aalto University
School of Science
Degree Programme in Information Networks

Merituuli Melkko

Challenges and Tensions in Emerging Data Sharing Networks

A Case Study in the Manufacturing Industry

Master's Thesis
Espoo, 4th of June, 2018

Supervisor: Professor Riitta Smeds, D.Sc.
Advisor: Miia Jaatinen, D.Soc.Sc.

Aalto University
School of Science
Degree Programme in Information Networks

ABSTRACT OF
MASTER'S THESIS

Author: Merituuli Melkko

Title:
Challenges and Tensions in Emerging Data Sharing Networks A Case Study in the Manufacturing Industry

Date:	4th of June, 2018	**Pages:**	131
Major:	Information Networks	**Code:**	TU-124
Supervisor:	Professor Riitta Smeds, D.Sc.		
Advisor:	Miia Jaatinen, D.Soc.Sc.		

The increase of Big Data collected from digitalised products and services is driving companies towards seeking additional value through Big Data analysis. For many companies, this requires competences they do not have. Additionally, more value would be gained by gathering and using data from their value chain as well as their own. These two aspects are driving companies to form networks and ecosystems of organisations sharing data to co-create value.

This thesis studies the challenges emerging networks or ecosystems face when seeking to co-create value by sharing data. In this thesis new theoretical understanding on challenges and tensions in emerging networks is built, and the specific challenges data sharing for value co-creation brings are investigated through a literature review and an empirical study. Based on these, practical guidelines on how to approach data sharing in a similar situation are constructed.

In its theoretical framework, this thesis combines literature about value networks and ecosystems with literature about data sharing and data as goods. This framework is complemented with theories of forming a shared understanding and data markets.

The empirical case study of this thesis examines a single case of an emerging value network in the pulp industry, where the members of a value chain are seeking to transform their business by providing additional value with Big Data analysis. Three managers from three of the relevant companies in the network were interviewed.

This thesis adds to theory by providing a framework of interlinked challenges and tensions that relate to emerging networks and ecosystems or data sharing, that has been synthesised from various literature and tested in an empirical study. The results of this thesis suggest that a network experiences both challenges and tensions related generally to working in networks and data sharing and that members of the network perceive challenges and tensions differently. The results also provide ways of mitigating these perceived challenges.

Keywords: Big Data, data sharing, digital transformation of business, emerging value networks and ecosystems, Internet of Things, value co-creation

Language: English

Aalto-yliopisto
Perustieteiden korkeakoulu

Aalto-yliopisto
Perustieteiden korkeakoulu
Tietotekniikan koulutusohjelma

DIPLOMITYÖN
TIIVISTELMÄ

Tekijä:	Merituuli Melkko		
Työn nimi:	Haasteet ja jännitteet syntyvissä tehdasteollisuuden dataa jakavissa verkostoissa		
Päiväys:	4. kesäkuuta 2018	**Sivumäärä:**	131
Pääaine:	Informaatioverkostot	**Koodi:**	TU-124
Valvoja:	Professori Riitta Smeds, TkT		
Ohjaaja:	Miia Jaatinen, YTM		

Digitalisoiduista tuotteista ja palveluista kerätyn Big Datan määrän kasvaessa yhä useammat yritykset ovat ajautuneet etsimään lisäarvon tuottoa Big Data -analyysistä. Monilta yrityksiltä kuitenkin puuttuu tämän analyysin vaatima tietotaito, ja lisäksi lisäarvoa tuottaisi datan tuominen heidän arvoketjustaan. Nämä asiat ajavat yrityksiä muodostamaan arvoverkostoja ja ekosysteemeitä, jotka jakavat dataa yhteisluodakseen arvoa.

Tämä tutkimus perehtyy haasteisiin, joita muodostuvat arvoverkostot tai ekosysteemit kohtaavat, kun ne pyrkivät yhteisluomaan arvoa jakamalla dataa. Tutkimuksessa luodaan kirjalliskatsauksen ja empiirisen tutkimuksen avulla uutta teoreettista ymmärrystä haasteista ja jännitteistä muodostuvissa arvoverkostoissa, sekä niistä ominaishaasteista, joita datan jakaminen verkostossa tuo mukanaan. Tutkimus tuottaa myös suosituksia siitä, miten vastaavissa tilanteissa datan jakamista verkostossa tulisi lähestyä.

Tutkimuksen teoreettisessa pohjassa yhdistetään kirjallisuutta arvoverkostoista ja ekosysteemistä kirjallisuuteen datan jakamisesta ja datasta hyödykkeenä. Teoriapohjaa täydentävät yhteisen ymmärryksen luomisen sekä datamarkkinoiden kirjallisuus.

Tutkimuksen empiirisessä osassa taas tarkastellaan yksittäisenä tapaustutkimuksena yhtä muodustumassa olevaa puunjalostosteollisuuden arvoverkostoa, jossa arvoketjun jäsenet pyrkivät muuttamaan liiketoimintaansa tuottamalla lisäarvoa Big Data -analyysin avulla. Tutkimusta varten tehtiin kolme haastattelua kolmen arvoverkoston yritysten edustajan kanssa.

Tutkimuksessa kehitetään teoriakehys muodostuvan dataa jakavan arvoverkoston yleisistä ja dataan liittyvistä haasteista ja jännitteistä. Teoriakehyksessä muodostetaan yhteyksiä haasteiden ja jännitteiden välille teorian ja empirian perusteella. Tämän tutkimuksen tulokset osoittavat, että arvoverkoston eri jäsenet eivät koe verkoston haasteita samoin, ja että dataa jakava arvoverkosto kokee sekä yleisesti verkostossa työskentelemiseen, että datan jakamiseen liittyviä haasteita ja jännitteitä. Tulokset lisäksi tarjoavat tapoja helpottaa näitä haasteita.

Asiasanat:	arvon yhteisluonti, Big Data, datan jakaminen, liiketoiminnan digitaalinen transformaatio, syntyvät arvoverkostot ja ekosysteemit, teollinen internet
Kieli:	Englanti

Acknowledgements

Writing a Master's Thesis was to me a great challenge set far away to the future, that I did not believe I would overcome. Yet I decided I would not stop after my Bachelor's, but to go through this rock, chip away at it step by step. After months of chipping, the rock is gone, and I am proud. I never believed I could do this, but I did.

First of all I would like to thank my supervisor Riitta Smeds for the chance to write this thesis in the SimLab community, and for her continuous guidance, interest and trust in my work. I would also like to thank my advisor Miia Jaatinen, who provided insights that helped me get forward.

A special thanks goes to the Guild of Information Networks Athene for making me belong and believe that I could do anything I set my mind into, telling me that it is okay that I did not know what I want my job title to be when I graduate, as long as I knew *who* I want to be.

I would like to give my eternal love and gratitude to Dionysus for always having my back, supporting me with whatever I needed at that moment, whether it be good advice, a listening ear or sparkling wine. In addition, I would like to remember Joutomiehet for giving me a home, and for not preventing me from graduating in the end.

Furthermore, a sincere thank you goes out to anyone, friends and family, who held my hand during this process, and believed in me more than I believed in myself.

Finally, I would like to thank my closest friend Maggie, who gave me the strength to persist until the spring days after a long winter come.

Espoo, 4th of June, 2018

Merituuli Melkko

Abbreviations and Acronyms

DLT	Distributed Ledger Technology
ICT	Information and Communication Technology
IoT	Internet of Things
IT	Information Technology
KPI	Key Performance Index
NDA	Non-Disclosure Agreement
OEM	Original Equipment Manufacturer
OT	Operational Technology

Contents

List of Tables

Chapter 1

Introduction

This thesis studies the challenges of transforming an existing manufacturing industry value chain into a value network that seeks to share Big Data to create additional value. The study consists of two parts: a theoretical and an empirical one. The theoretical research delves into the existing literature of data sharing in value networks and the aspects that have made this a viable and profitable form of creating value for organisations, and what factors are important in a transformation towards this kind of business. The empirical research consists of interviewing members of an existing business value chain that are seeking to create value by sharing Big Data and working in a network rather than a value chain.

Combining the findings from the theoretical and the empirical research, this thesis has both theoretical and practical contributions. The theoretical contributions include a framework of tensions and challenges that a data sharing network has to respectively balance and overcome, and links between these tensions and challenges. Furthermore, this thesis provides an extensive theoretical look into concepts and phenomena related to data sharing and emerging networks and ecosystems. The practical contributions include suggestions and ideas for what to take into account when seeking to form a data sharing network or ecosystem, and how the challenges that the network or ecosystem is likely to face could be overcome, and the tensions could be

balanced.

In this chapter, the background of the phenomenon that is studied is presented to give the motivation of this thesis and to lead into the case that has been chosen to examine the phenomenon in. Furthermore, the research problem and the structure of this thesis are introduced.

1.1 Background and Motivation

According to Kurzweil (2004), the speed of the development of technology is exponential rather than linear, and thus difficult for people as individuals and companies to grasp and stay on top of. Still, the quick developments of technology open up major possibilities for innovation that companies can leverage to their benefit (Manyika et al. 2013). If they do not, they are likely to lose to their competition, if they are unable to adapt to change and their competition does (Raynor & Cotteleer 2015, Weill & Woerner 2015).

Digitisation is the technical conversion of analog information, for example sound, image or text, into digital form (Alasoini 2015, Negroponte 1995). Digitalisation is using the possibilities that stem from digitisation to create new types of business, transforming societies towards an increasingly digital era (Alasoini 2015, Lasi et al. 2014, Lavikka et al. 2017, Loebbecke & Picot 2015, Weill & Woerner 2015). With digitalisation lowering the costs of development and production of digitalised products through improved means of production and lowered cost of parts and material, it is much easier for new entrants to access markets and threaten incumbent companies than before (Lasi et al. 2014, Manyika et al. 2013, Porter & Heppelmann 2014).

As a response to the threat of digitalisation towards existing business, companies must change the way they work within their companies and with the companies around them in order to be able to compete in the markets of today and tomorrow. They have to question the very core concepts of their industry and business such as how they produce and capture value to customers (Porter & Heppelmann 2014, Raynor & Cotteleer 2015). This

phenomenon of thorough change in industries through digitalisation is called digital disruption of industries (Weill & Woerner 2015), or alternatively, the fourth industrial revolution, Industry 4.0 (Lasi et al. 2014).

As with any change that threatens companies and industries, companies need to learn in order to be able to not only adapt to it, but to turn it into a competitive advantage (De Geus 1988), and the same applies to the digital disruption of industries. According to Manyika et al. (2013) and Evans & Annunziata (2012), with the advancement of technology, huge opportunities lie in harnessing these advancements in the working processes of the company, improving productivity.

One of the great trends of digitalisation and the digital disruption of industries is the Internet of Things (IoT). IoT can be defined as the interconnected network of sensing and acting "things" that are able to share information across platforms (Atzori et al. 2010, Gubbi et al. 2013, Raynor & Cotteleer 2015). IoT allows companies to observe, identify, analyse and evaluate their business processes, products and their uses in ways that were impossible before (Raynor & Cotteleer 2015). This is possible through IoT creating large amounts of data, called *Big Data*, which offers immense insights to one that can analyse and harness it in a way that gains them understanding about their processes or ideas how to fine-tune them for higher efficiency (Russom 2011, Turner et al. 2014, Weill & Woerner 2015).

According to Russom (2011), Big Data was a serious problem only some years ago in the beginning of the 2000s, as data volumes skyrocketed, but the infrasystems from that time were unable to scale to the amount of data. More recently, however, the price of storage and CPUs have dropped drastically, so the collection and storage of data is not a problem (Russom 2011). However, the transfer of large quantities of data, which is required if the analysis or storage is done e.g. in a cloud or in another company, is still a challenge due to the demands it sets for the ICT network (Manyika et al. 2013). As such, there are still technological challenges to solve.

According to Gantz & Reinsel (2012) and Turner et al. (2014), due to

the trends of digitalisation, including IoT, the size of the digital universe is estimated to increase from 2013 to 2020 from 4.4 trillion gigabytes to 44 zettabytes, that is, grow by a factor of ten, doubling every two years. This includes all data on the internet, but of course, a very small amount of that data is useful and interesting for companies seeking competitive advantage (Gantz & Reinsel 2012, Turner et al. 2014). This poses the question of how to find data that is usable and useful for a company, and how to analyse it in order to provide its potential value. The answer to this is Big Data analytics, that strive to analyse and interpret any kind of digital information that is large, unstructured and fast-moving into something that creates business value (Loebbecke & Picot 2015, Manyika et al. 2013, Russom 2011).

Manyika et al. (2013) claim that after the healthcare industry, the manufacturing industry has the biggest potential to profit from IoT and Big Data analysis through improvements to efficiency in production and managing the value chain. This potential of harnessing IoT and Big Data analysis in the manufacturing industries is called *smart factories* (Kagermann 2015, Lasi et al. 2014). Smart factories use ubiquitous computing and decentralised information systems to manage production processes optimally (Lucke et al. 2008).

According to Manyika et al. (2013), the low cost of sensors and the high demand for the optimisation of processes in the manufacturing industry could lead to very high adoption rates of IoT. Based on their estimates, IoT applications could be used in 80 to 100 percent of all manufacturing by 2025 (Manyika et al. 2013). The economic potential of this type of adoption of digitalisation would according to Manyika et al. (2013) lead potentially to an economic impact of $900 billion to $2.3 trillion per year by 2025.

However, this might be optimistic, as adapting new technical advancements has proven to be slow even in fields where considerable gains could be achieved (David 1990, Manyika et al. 2013). According to David (1990), it took two decades for the dynamo, the first type of an electric motor, as a technology to reach 50 percent of the factories in the United States and

several more before its total impact to productivity could be observed. The reasons behind this were that the legacy technology had been heavily invested in and adopting the new technology required investing into new equipment and facilities (David 1990, Manyika et al. 2013). David (1990) also argue that there may be similar reasons behind to why the productivity increases of adopting new IT systems are not immediately visible.

However, as Manyika et al. (2013) note, the adoption rates of different technologies vary greatly from one technology and area to another, depending on timing and a number of other factors, making it difficult to estimate the rate of adoption accurately. For Big Data analytics, the investment into collecting data has already been done, and the major challenge is transferring and analysing them to create the productivity and business value they have potential for (Russom 2011). Immense amounts of data are collected, of which only small amounts are used, and it is unknown which bits of information in the large amount of unrefined, unused data could give more insights to the operating company (Russom 2011). However, Cohen (1998) states: "Even small, incremental knowledge can distinguish an organization from its competitors".

By this Cohen (1998) is referring to knowledge as information *in context*, for example understanding about a process that can be used to improve it. Even small process improvements in the manufacturing sector cause significant savings (Manyika et al. 2013). This makes the analysis of Big Data an appealing aspect for companies in the manufacturing industry, as even the smallest of applications can bring considerable advantage for a company over its competitors.

As the manufacturing industry seeks to improve its processes through Big Data, a critical question emerges on how they can acquire the required competences to do it. A manufacturing company has a lot of understanding about its processes, but software development, systems engineering and data analytics are expertises that are rarely found in manufacturing companies (Porter & Heppelmann 2014). Unless they choose to acquire the analytics

competences for themselves, they are driven to cooperate with other companies. Cooperating with other companies to analyse and harness the Big Data would require sharing data and forming the required structures for it, driving towards network-type continuous collaboration (Akkermans et al. 2004, Porter & Heppelmann 2014).

Together these trends make the sharing of data in the manufacturing industry an appealing although challenging task to undertake, especially since it has been gathered over the years without gaining much of its potential value (Russom 2011). However, increasingly complex products and massive amounts of data that are not fully understood complicate dealing within the network, and especially incumbent value chains or networks may have trouble adjusting to the change (Porter & Heppelmann 2014, Raynor & Cotteleer 2015).

This thesis studies the complexity and challenges of data sharing in the emerging type of inter-organisational value creation for new business in the context of the manufacturing industry.

1.2 Research Problem

To address the many open questions raised in the previous section, this thesis focuses on the following research problem:

> **What are the challenges and tensions in emerging manufacturing industry networks that seek to share data?**

This research problem is approached in Chapter 2 through a literature review into business networks and their challenges, the forming of business ecosystems and trading in data, specifically the requirements of markets for data and the value of data. Additionally, literature about creating shared understanding about data-driven value creation is considered in the context of networks.

At the end of Chapter 2, the literature review is summarised, and based on the summary, research questions for the empirical study are formed. The

empirical research questions relate to the findings of the literature review so that the results from the empirical research part of this study may be compared with the existing knowledge in the field.

The objective of this study is to find out what types of challenges and tensions the members in an emerging manufacturing industry network experience while forming their network to share data for value co-creation.

1.3 Research Approach and Scope

This study takes a qualitative approach to gain a better understanding about its research problem. By its definition, as made by Creswell (2009), qualitative research studies the uniqueness and complexity related to situations handling human issues and offers the chance to examine those types of topics in sufficient depth and an open-ended question setting. In qualitative research, the analysis of data is based on the researcher's interpretations, and as such, it is influenced by the researcher's prior knowledge and understanding about the subject (Creswell 2009).

This study is conducted as a single case study. Case study is used as a method typically when the research focuses on a real-life phenomenon or event and its nature or the reasons of its occurrance, where the researcher has little control over the studied phenomenon (Yin 2009). According to Yin (2009), the scope of a case study is an empirical inquiry into a contemporary phenomenon, studying it in depth and within its real-life context. It is especially appropriate when the boundaries between the phenomenon and its context are not well known (Yin 2009). This is exactly the situation when studying an emerging new business network, driven by the exploitation of digital data, so choosing case study as the research method is appropriate.

This study examines a single case of one existing network of companies in a supply chain in the pulp industry. The case was selected by the researcher to be able to assess the real-life circumstances of working with Big Data amongst several companies that are well established and that are already

doing business together. The case allows the researcher to see what sort of change data sharing brings to the companies and what sort of challenges arise. Through the case study, this thesis aims at theoretical generalisations to increase theoretical understanding of the phenomenon, not at empirical generalisations to other companies and contexts.

An abductive inference logic is applied to the research problem. Unlike in an purely deductive or inductive approach, in abductive reasoning the theoretical literature and empirical observations are not tested against one another, but rather, literature and empirical data are constantly compared, combined and refined over the course of the study (Dubois & Gadde 2002, Kovács & Spens 2005). This comparison, combination and refining is done throughout the process in iterative cycles that explain one another to reach the best theoretical explanation for the studied real-life phenomenon (Kovács & Spens 2005).

Furthermore, the abductive logic explicitly accepts the role of the researcher as the final arbiter between competing explanations, and focuses on the descriptive aspects of scientific reasoning over the normative (Ketokivi & Mantere 2010). As this study is a case study, an abductive approach is especially fitting, as an abductive approach to reasoning not only allows deeper understanding of the case, but makes it possible to construct a better theory towards a theoretical generalisation, as opposed to a statistical one (Eisenhardt 1989).

The data of this thesis is mainly recordings of interviews conducted with individuals that represent the organisations of the selected network. During these interviews, a boundary object where the interviewed members' companies are represented was used to facilitate the conversation and to bring the discussion about the network and its data sharing into context. A boundary object is an object that has meaning over multiple different contexts and because of it, can be used to convert meaning from one context to another (Carlile 2002, 2004, Star 1989). In the case of this study, the boundary object is used as a means of conversation and furthering the formation of a

shared understanding between the researcher and the interviewee. A boundary object created by the researcher was modified by the researcher and the interviewee to accurately represent the interviewee's views about the subject.

The original boundary object template and the resulting boundary objects were used as additional data in this thesis. Other material used in this study includes observational data from workshops, recordings of workshops and video material of one workshop where the possible value that the network could create, and the related challenges, were discussed between the companies, facilitated by researchers.

The interviews themselves were conducted as thematic interviews, following the framework presented by Hirsjärvi & Hurme (2000). Thematic interviews are compatible with both inductive and abductive inference logics (Hirsjärvi & Hurme 2000, p.136), and thus a suitable method for this study. The interview type is covered further in Chapter 3. The analysis of the interview data was done iteratively, loosely following the outline of qualitative content analysis as presented by Sarajärvi & Tuomi (2009), starting with reduction of the data to grouping of the findings and conceptualising them. The content analysis was done to be able to describe the investigated phenomenon and summarise it in a way that makes it possible to see the results in relation to a broader context, and compare it to other research done on the topic (Sarajärvi & Tuomi 2009).

1.4 Structure of the Thesis

This study consists of four parts: Introduction, Theoretical Framework, Empirical Study and Conclusions.

The first part of the thesis introduces the background and motivation of the thesis, presents the research problem and the theoretical research questions, and gives a brief introduction into the research approach and scope of the empirical research.

The second part of the thesis presents the theoretical framework of the

thesis by diving deep into the literature relating to the research problem. The theoretical framework is summarised, and empirical research questions are formed.

The third part of the thesis describes in depth the case that has been chosen as the object of study, and the data gathering and analysis process. At the end of the third part, the findings of the empirical study are presented and the empirical research questions are answered.

The fourth part of this study focuses on comparing the theoretical framework and the empirical study, discussing the findings and presenting the conclusions of the study. Implications of these conclusions are discussed and further research directions are described. At the end of the thesis, the limitations of the study conducted are considered, and its validity is evaluated.

Chapter 2

Theoretical Framework

In this chapter, a theoretical framework is constructed by approaching the research problem posed in the previous chapter through a literature review on relevant topics. The objective of the literature review is being able to provide a solid theoretical base to approach the research problem, and to enable forming relevant empirical research questions. After all the topics are covered, a theoretical summary is drawn, and the theoretical findings towards answering the research problem are presented. A theoretical framework is constructed, and empirical research questions are formed based on the theoretical findings made.

As explained in Chapter 1, the trend of digitalisation pushes companies into changing the ways they work within their company and with other companies. Digitalisation presents new threats and opens up new possibilities that require competences the companies have not needed before. This causes the companies to network with complementary companies due to the different competences required to satisfy the changing customer needs and to retain a competitive advantage and position on the market.

According to Lasi et al. (2014), the two main driving forces of the digital disruption of industry are technology push and application pull. Technology push in this context means that new technologies are pushing companies to adopt new ways of working and develop their products further (Brem & Voigt

2009). Application pull, on the other hand, means that the changes in the operative framework conditions are pulling companies to adapt their development and production to these conditions in order to be able to compete on the markets (Lasi et al. 2014). Application pull differs from market pull, which is the demand coming from the markets to solve an existing problem the customers have, as application pull is more of a "business innovation pull" that comes as a derivative of "technology push".

In the case of the digital disruption of industry, application pull is brought on by changes in the operating environment due to advancements of technology and changes in the social, economic and political environment, which enable companies to much advance and adapt their production and development and open up possibilities for innovation. Such changes include the shortened time-to-market from development to launch, the expected product individualisation for customers, higher flexibility requirements in production, requirements of resource efficiency in development and production, and the decentralisation of decision-making in order to be able to keep up the flexibility and speed of development and production (Lasi et al. 2014). These factors also push towards centralised production by favoring economies of scale (Loebbecke & Picot 2015). All of these changes cause major challenges to companies, as they have to rethink their operations and implement the changes necessary to exploit these possibilities.

Technology push, on the other hand, is coming purely from the technological advances not yet utilised or poorly utilised in production and development, which companies should adopt, if they wish to survive this disruptive revolution of industries. These trends and technologies include further automatisation, miniturisation and digitalisation (Lasi et al. 2014). These are the trends that push towards IoT, where small, smart sensors in products make the products smart (Porter & Heppelmann 2014), and fundamentally change the way value is produced and captured (Raynor & Cotteleer 2015).

Diving deeper into the consequences of the digital disruption of industries and the trends of IoT, it is worth to note that instead of focusing on a

single product, companies move to offer their products and services as platforms, answering to the demand by the customers and creating new needs for both their customers and their own business environment(Gubbi et al. 2013, Oliva & Kallenberg 2003, Porter & Heppelmann 2014). According to Porter & Heppelmann (2014), this diffuses the lines between industries, as companies seek to secure their position on the market by locking their customers into their platform solution. At the same time, to maintain a competitive edge, companies are driven to focus on their core competences, and thus to get complementary services or sub-products from other companies, forming relationships with complementary or even competing companies becomes necessary (Oliva & Kallenberg 2003, Popp et al. 2014, Ritala et al. 2014). According to Peppard & Rylander (2006) and Smeds et al. (2015), competition has shifted from between individual companies to between networks of interconnected organisations.

Due to this, it becomes necessary for companies to consider the challenges and requirements of working together with other companies and face the challenges of digitalisation together. For this reason, this thesis considers working in networks from many angles in order to be able to provide an accurate description of the demands companies face when seeking to transform their business into a networked one.

2.1 Networks as a Solution

As concluded before, the digital disruption of industries brought on by the advancing trend of digitalisation pushes companies towards transforming their business from working in traditional supply chains to working in networks. The purpose of this is that the value that they can create together with other companies exceeds what they can create with their own competences and resources, and this value co-creation is the core principle and driving cause of networks (Thomas & Autio 2014).

In value co-creation, several organisations or individuals come together to

create something of value to all of the participants, crossing inter-organisational and other boundaries (Adner & Kapoor 2010, Carlile 2004, Russo-Spena & Mele 2012, Smeds et al. 2015, Vargo et al. 2008). An interesting factor that Loebbecke et al. (2016) raises is that the knowledge and capabilities an organisation has is crucial in determining its competitive advantages and its success, but resource-leveraging strategies drive towards inter-organisational collaboration and the sharing of knowledge, which is contradictory to the need to protect the competitive advantage a company has. As such, the potential value that the network can create together must be worth the risk an organisation takes putting their competitive advantage on the line by sharing the knowledge they have (Loebbecke et al. 2016).

Another important aspect in networks and ecosystems is the matter of involving the customer into network, at least to the extent of taking their opinions about what value the network or ecosystem should create, and how (Albinsson et al. 2007, Lavikka et al. 2017, Russo-Spena & Mele 2012). Albinsson et al. (2007) argue that doing co-design that includes network members and the customer is crucial when innovating in networks, as bringing different people and their perspectives into the process makes it more well-suited for its purpose. Similarly, Leonard-Barton (1995) argue that innovation in most cases happens at the boundaries between specialisations, thus making it critical for networks that seek to innovate to have a variety of participants of different specialisations. This working across boundaries, while is an important factor contributing towards gaining competitive advantage, complicates working within these border-crossing organisations and networks (Leonard-Barton 1995, Carlile 2004).

An emerging trend has been a simultaneous competition and cooperation between two or more companies acting in the same industry in the same value chain position. This as a phenomenon is called coopetition (Bengtsson & Kock 2000, Ritala et al. 2014). According to Ritala et al. (2014), firms are more and more collaborating with their active competitors in order to gain the benefits of network collaboration. Those benefits include min-

imising and sharing costs, sharing risks, resources and distribution channels, co-marketing, increasing service quality, and collaboratively innovating and learning (Popp et al. 2014, Ritala et al. 2014). When cooperation is successfully managed and these benefits are achieved, they are a major advantage in the competitiveness of these companies over other companies in the industry in various contexts (Ritala et al. 2014). However, when competing firms collaborate, it puts additional pressure on a networked collaboration. Coopetition may not be suitable for all situations, so deciding to engage in it needs to be well considered.

Keast et al. (2004) state that a very common trigger for starting to develop inter-organisational networks is some kind of a crisis that affects the companies. When considering the digital disruption of industries, such a crisis can be the threat in competition that it brings. Another reason for seeking to work in networks can be the possibilities digitalisation brings and through them the chance to gain advantage and beat other players in the industry (Manyika et al. 2013, Porter & Heppelmann 2014). However, how do companies know when an inter-organisational network is the best way to compete in their field?

Popp et al. (2014) argue that collaboration between companies, although beneficial, comes with a variety of challenges, and thus proper consideration needs to be given on when a business network gives more worth than it is trouble. Sometimes, a network is not the right organisation form to solve the problem it is seeking to solve (Popp et al. 2014). The following questions are suggested to be considered when a network is formed to evaluate the necessity of the network:

1. Is the identified problem beyond the capacity of any one organisation?
2. Is this a problem or issue where the stakes are high?
3. Is the issue complex?
4. Have other traditional methods already been tried?
5. Is it likely that a common aim could be identified and agreed to?

6. Do the organisations involved have similar cultures and values?
7. Is there enough diversity among potential participants to provide multiple perspectives on the problem?
8. Is there a history of trusting relationships among the organisations that would comprise the network? If not, is there enough time to develop them before tangible outcomes are expected?
9. Will there be the necessary resources to develop and implement a network?
10. Is the issue one that will require long-term collaboration?

When considering these questions in regards to the trends of digitalisation that are driving companies towards working in a network, some of them can be answered by the context. Number 1 is assumed to be true as to harness the possibilities of digitalisation, a company needs new competences they do not possess previously. Gaining this type of competence takes considerable amounts of time, and in addition, to form a platform on their own is out of the reach of any one company (Porter & Heppelmann 2014). If a platform solution is what the company is after and they need a lot of new competences, solving that on their own is likely out of their capacity, and as such, the answer to question 1 would be yes.

As for question 2, as previously stated, the trigger for companies to start developing networks in the face of digitalisation can be the perceived threat of losing to the competition either accompanied with the possibility to gain advantage through innovation or not. This, according to Keast et al. (2004) is an indicator of the stakes being high, which would make the answer to question 2 positive. The answer to question 3 is also positive based on the complexity that digitalisation brings. In addition to these three, the answer to question 10 can be said to likely be positive when it comes to a similar situation as the one considered in this thesis, as the type of collaboration required would not be enough to be implemented in a single project, but rather in a continuous manner (Akkermans et al. 2004).

These four questions in the list of ten are not organisation dependent but issue dependent. What is more, four out of ten questions already getting a positive answer due to the issue at hand indicate that it is likely that a network is the correct solution for a problem such like considered in this thesis. However, to verify this, the ten questions presented are used to assess the necessity of a network in an empirical case study presented in Chapter 3.

2.1.1 Challenges of Networks

It is important that the reasons for choosing a network as the form of organization to be right, because compared to the work of a single organization, a network of organisations working together to achieve a goal is much more complex and comes with a lot of challenges (Popp et al. 2014). According to Russo-Spena & Mele (2012), especially when it comes to supply chain type of business networks, the biggest challenges the network faces when seeking to digitalise their value production have to do with differing working practices, interests and economic models of the members of the network. This contradicts the assumption many companies have that digitalisation is something that they can master by only adopting or creating the technical tools (Lavikka et al. 2017, Russo-Spena & Mele 2012).

According to Kagermann (2015), technology is an important driver of new possibilities, but its challenge is that an organisation seeking to harness it must deal with the fears that relate towards adopting a new technology. These fears include losing power and control, the fear of becoming too transparent and thus losing competitive advantage, and how they can protect their data and the privacy of their customers (Kagermann 2015). Kagermann (2015) emphasises that when adopting a new technology, it is important to view it as something that will save money in the future, rather than as the waste of the time it takes to adopt it. Also not all of an organisation's employees have the ability to adapt to a new technology as quickly as some, so adopting a new technology may cause fears and uncertainty amongst the

work force as well (Coch & French Jr 1948, Kagermann 2015).

Popp et al. (2014), based on an extensive review of relevant literature on the subject, list the following challenges as something every network has to consider:

1. **Achieving consensus on and commitment to network purpose and goals:** Participating organisations have varying needs and goals and aligning these towards the network purpose is complicated
2. **Culture clash or competing working practices** Member organisations can have different ways of working that make it challenging to agree on essential structures and processes
3. **Loss of autonomy:** Coordinated decision-making can cause resistance in member organisations, especially if they feel that the decisions made are not in their best interests
4. **Coordination fatigue and costs:** Collaborative working takes a lot of time and effort that could be spent in the daily work of the organisation, and as such is seen as a negative thing
5. **Developing trusting relationships:** Trust takes time to build and it must be maintained in order for the companies to be willing to share their competences and knowledge openly
6. **Obstacles to performance and accountability:** There must be clear rules about responsibility and monitoring that each organisation does theirs to avoid inequality and free-riders
7. **Management complexity:** Managing networks means managing both across organisations and within the member organisations, and this is complex, as managers need to be able to handle conflict that arises between the cooperation in the network and the workings inside an organisation.
8. **Power imbalance and resulting conflict:** As companies collaborating are inevitably of different sizes and have differing amount of

resources, it becomes important to make sure that the members of the network feel that despite the differences, they are treated fairly and their interests are considered when setting goals and ways of working

9. **Lack of organisational capacity to work collaboratively:** Working in a network is a different way of working, and as such it requires learning in the organisations that are members of the network
10. **Sustainability:** The challenges and complexity of working in a network make sustaining it difficult, and the environment being ever-changing further complicates it

These challenges by Popp et al. (2014) are examined in this thesis against other relevant theoretical literature in the field to examine how they compare to studies from other fields and especially when it comes to the handling of data across organisations.

In addition to the challenges presented by Popp et al. (2014), due to the focus of this thesis into an emerging network seeking to co-create value via data sharing, another challenge the network has to face is the **resistance to change**. Resistance to change is the reluctance and resistance the employees in an organisation display towards adapting to a change, regardless of whether it is beneficial for the organisation and their productivity or not (Coch & French Jr 1948). According to Coch & French Jr (1948) and Kagermann (2015), resistance to change is inevitable but not unmanageable when organisations encounter the need to change.

According to Popp et al. (2014), the main three themes that are related to mitigating the challenges a network faces and implementing an effective network that are discussed broadly in literature are **network governance**, **network structures** and **management and leadership of and in networks**. These are the main tools that affect these challenges and that also can be used to combat them, and as such, they are important to consider when looking to form a network (Popp et al. 2014).

Popp et al. (2014) use the definition of network governance by Provan & Kenis (2008), which entails the governance structure the managers have

chosen for the network. According to Provan & Kenis (2008), a network can either be governed in a shared manner, by a lead organisation or a separate network administration organisation. Network governance forms a basis for the functioning of the network, and it highly depends on the size of the network, a larger size typically narrowing the distribution of trust within the network and decreasing the consensus about goals (Popp et al. 2014, Provan & Kenis 2008).

As such, shared governance of a network is suitable for a small network where there is a lot of trust present, and the lead organisation or network administration organisation governance models work better when the size of the network increases (Provan & Kenis 2008). The difference between a network that is governed by a lead organisation towards one that is governed by a network administrative organisation is that the lead organisation is one from within the network, typically the most powerful one, and a network administrative organisation is a organisation from outside of the network appointed to take care of the network governance (Provan & Kenis 2008). Network governance adds to and overlaps with network leadership and management (Popp et al. 2014).

According to Popp et al. (2014), it is widely agreed that the management and leadership of networks is challenging. Regardless, leadership in networks is required for the visioning of the goals and the focus on the processes and relationship building between network participants (Milward & Provan 2006, Popp et al. 2014). Management is addressing the tensions inherent to the network while managing the commitment, accountability and legitimacy of the network, and balancing the different needs of the organisations taking part in the network (Milward & Provan 2006).

Network structure, on the other hand, helps in making the network as effective as it can be (Popp et al. 2014). According to Popp et al. (2014), the structure of a network consists of its nodes and the links that connect them, that is, the organisations and their relationships within the network. Some of these ties are weak and some are strong, but according to Popp

et al. (2014) and Granovetter (1983), both are valuable to the network as they serve different purposes in it.

Together these three attributes form the base of how the network is built and how it functions. Through these three aspects the network has tools to address the challenges it faces, and to understand the aspects specific to that network. Networks with different types of structure and governance structures require different types of management, and face different types of tensions.

2.1.2 Tensions in Networks

Provan & Kenis (2008) outline three key tensions that are affected by governance structures, but appear in every network in some way and thus have to be faced by its managers.

1. **Efficiency vs. inclusiveness:** Decision making of a network needs to be efficient, and more efficient decision-making means involving as few participants as possible, but for the sake of trust, members of the network need to feel included in the decision-making to some degree.
2. **Internal vs. external legitimacy:** Both legitimacy within the network and to the external stakeholders of the members of the network need to be asserted and gotten support and commitment for.
3. **Flexibility vs. stability:** Networks are typically considered to be flexible and able to thus adapt to changes in the industry, but the participants need some stability in the network to feel secure.

The tensions presented by Provan & Kenis (2008) link also to the network governance mechanisms, that were introduced in the previous section. According to Provan & Kenis (2008), in general, a network that is governed in a shared manner will favor inclusion, internal legitimacy and flexibility, whilst in lead organisation governed networks efficiency, external legitimacy and stability are favored. Networks governed by a network administrative

organisation balance efficiency and inclusiveness and internal and external legitimacy, but favor stability over flexibility in a similar way as lead organisations do (Provan & Kenis 2008, p.245).

Combining the links between network governance mechanisms and tensions with the knowledge of how the network size affects the choice of a network governance model, conclusions can be drawn that a network with fewer participants is more likely to focus on the inclusiveness of its members, its internal legitimacy and maintaining the flexibility of the network. Large networks have the choice of being governed by a lead organisation or a separate network administrative organisation, and the tensions that the network experiences are affected by this choice as well.

A tension that is related to the Efficiency vs. Inclusion tension described by Provan & Kenis (2008) is the tension of **Unity vs. Diversity**, identified by Saz-Carranza & Ospina (2011). Unity in a network brings the organisations together with a feeling of belonging and brings them to function in accord, whilst diversity in a network means that the differences of the members of the network are used to bring out unique value (Saz-Carranza & Ospina 2011). Saz-Carranza & Ospina (2011) link together network effectiveness and the tension of Unity vs. Diversity, claiming that while both unity and diversity are required for network effectiveness, they may undermine one another, as diversity can push towards disunity and unity can push towards similarity.

Combining the tensions of Efficiency vs. Inclusion, Unity vs. Diversity and the importance of collective identity of a network, it becomes obvious that it is crucial for the network manager to find ways to effectively balance these conflicting tensions and needs (Popp et al. 2014). Saz-Carranza & Ospina (2011) propose several ways to cope with the Unity vs. Diversity tension, with the main emphasis being on the shared identity of the network, its main goal and defining the value of diversity and how each member contributes towards the goal. Similarly, Hardy et al. (2005) argue that having a collective identity is crucial in achieving effective collaboration.

Hardy et al. (2005) define *effective collaboration* as interorganisational cooperative action which results in innovations that bring synergistic advantages to the members of the collaboration and that balance their diverging stakeholder concerns. They argue that effective collaboration is dependent on the relationships between the participating members, and that these relationships are shaped and negotiated continuously throughout the collaboration, forming a collective identity. A collective identity in this case means that the members of the collaboration perceive themselves as part of a team of sorts, striving towards the same goals instead of conflicting ones (Hardy et al. 2005, Inkpen & Tsang 2005, Kilker 1999). Thus, the importance of the identity of the network rises further, as it also affects how the goals of the network are perceived. The main goals of a network are another important factor in dealing with the Unity vs. Diversity tension according to Saz-Carranza & Ospina (2011).

However, when considering the possible tensions in a network, it is important to note that how largely the tension affects a network can differ greatly due to differences in network compositions and choice of governance models, and over time of the network's formation. Popp et al. (2014) argue that what may be a problematic tension at one time in the network, may be either irrelevant or even an asset at another. Due to this, it is important to investigate what the tensions are that are causing a network trouble, and what are the ones it is experiencing as less problematic. This is something that needs to be evaluated in the empirical case to gain further understanding about the dynamics of the emerging network.

2.2 Towards a Business Ecosystem

Coming closer to the case that was selected for this thesis, a somewhat similar situation and network was examined in the article by Lavikka et al. (2017). Lavikka et al. (2017) studied via interventions a case where a supply chain was seeking to digitalise its processes and share data amongst its members.

Notable here is that instead of considering a narrow network of participants, in the case studied by Lavikka et al. (2017) the whole ecosystem around the network was considered, and propositions were made towards an emerging business ecosystem and value that could be created for the whole of it. Based on this, literature on business ecosystems is considered for this thesis as well, and the differences between a value network and a business ecosystem are examined to be able to categorise and approach the chosen case properly.

Combining the trends of forming closer ties with other companies to the point of forming networks and moving from products to platforms, supply chains are moving towards forming business ecosystems around the developing platforms, and this transformation is both a threat and an opportunity for the existing members of the supply chain (Lavikka et al. 2017, Lusch et al. 2010). Iansiti & Levien (2004) talk about a business ecosystem as a larger setting and system that companies move towards when looking beyond the value chain to consider a wider network of value creating participants, including all organisations that affect the core organisation of the system.

In their article seeking to combine existing literature of business ecosystems to get one comprehensive definition of the term, Peltoniemi & Vuori (2004) define a business ecosystem as a dynamic structure which is made of interconnected organisations. According to Peltoniemi & Vuori (2004), these organisations can be of varying types, from small firms to large corporations and organisations from the public sector or specialising in research. A business ecosystem is the community and environment of other organisations around an organisation that support one another (Moore 1996), and are dependent on one another in the sense that in a thriving ecosystem, the companies flourish together, but when the ecosystem is not doing well, its members suffer from it (Iansiti & Levien 2004). Business ecosystems are dynamic and purposeful networks, where their participants co-create the value of the network (Adner 2006, Adner & Kapoor 2010).

Thomas & Autio (2014) define the following three important ecosystem

characteristics:

1. **Network of participants**, where each participant brings to the network their own complementary input towards to the system. These complementary inputs create value for the network.
2. **Governance structure**, which provides the authority structure for decision making within the network, coordinating the interactions of its members.
3. **Shared logic**, which consists of the participants' shared understanding about their interdependency, considering the legitimacy, trust and shared awareness of each other within the network.

These ecosystem characteristics describe what an ecosystem needs and how it can work towards its purpose, which is the co-creation of value (Adner 2006, Adner & Kapoor 2010, Lavikka et al. 2017, Thomas & Autio 2014).

Firstly, the network of participants. A business ecosystem has a clear distinction of who belongs to the ecosystem and who does not, and a business ecosystem is built with the purpose that each member has something to contribute to it (Gulati et al. 2012, Iansiti & Levien 2004). According to Thomas & Autio (2014), these members are specialized, their inputs are complementary and they co-evolve together with the other members of the ecosystem.

This theme is also found in other research. The interconnectedness and interdependency of the participants of the network is recognised as a key element of business ecosystems (Adner 2006, Adner & Kapoor 2010, Iansiti & Levien 2004, Gulati et al. 2012). Iansiti & Levien (2004) sees the interconnectedness within a business ecosystem as an enabler and the interdependency as an motivator for knowledge sharing and creating knowledge cooperatively, which would make them a factor contributing towards the commitment of the participants towards the network. To the participants of the ecosystem, this means that they are tied to the ecosystem they are in, and depend on the ecosystem as something that will greatly affect them. Iansiti

& Levien (2004) use the term *shared fate* to describe that the ecosystem fails and wins together.

The governance system of a business ecosystem is the coordinator of the actions of its participants (DiMaggio & Powell 1983, Gulati et al. 2012, Thomas & Autio 2014). That is, the role of a governance system is to manage the network as it works towards its purpose. The governance system consists of an authority structure, membership control and task coordination (Thomas & Autio 2014). This is similar to the governance structure and leadership and management of a network as used by Popp et al. (2014) and Provan & Kenis (2008).

DiMaggio & Powell (1983) recognise that the direct and indirect relationships between the companies and their differing levels of power on each other result in interorganisational patterns, where companies form coalitions and the ones with more power dominate over the others. Thomas & Autio (2014) build on this that due to the different levels of power that the companies have, there is an authority structure between the companies. These differences in power, however, are also a challenge for the business ecosystem, as presented by Popp et al. (2014).

The importance of membership control in a business ecosystem comes from the previously mentioned shared fate of the ecosystem. In membership control, Gulati et al. (2012) underline the importance of choosing how open the network is to new members, as who the members of the ecosystem are fundamentally affects the dynamics of value co-creation. The members chosen for the network also affect the Unity vs. Diversity tension in the network and the network's collective identity, as who they are bring the diversity into the network, and how well they work together and how well they agree on the goals affects the unity of the network (Saz-Carranza & Ospina 2011).

Task coordination is required for the smooth operation of the business ecosystem so that the divided tasks can be executed properly (Thomas & Autio 2014). Task coordination is part of the management of accountability in the network Milward & Provan (2006). According to Thomas & Autio

(2014), this part includes the contract that outlines the rules and regulations that govern the interactions between the participants of the ecosystem, the coordination processes of the management of the network and any technological platform that enables and restricts interaction.

Task coordination directly addresses and deals with the challenge of Obstacles to Performance and Accountability and adds to the challenge of Management Complexity, as defined by (Popp et al. 2014). The contract helps to outline the responsibilities of each organisation in the business ecosystem, and the technological interface to manage task division and interactions between the members increases their accountability. Implementing task coordination, however, contributes towards Management Complexity, as managing the inter-organisational cooperation is complicated and requires a lot of effort.

2.2.1 Value Network vs. Business Ecosystem

In their work, Peppard & Rylander (2006) discuss the trend of moving from a value chain towards a value network. In their definition, a value network is a network of complementary economic actors, including suppliers, partners, allies and customers, who work together to produce value for the network (Peppard & Rylander 2006). Lusch et al. (2010) on the other hand define a value network as a loosely coupled network of organisations that co-produce service offerings, exchange service offerings and co-create value.

Lusch et al. (2010) emphasize that a value network, in contrast to a traditional supply chain, is mostly comprised of weak ties, as opposed to strong ones. Weak ties, as opposed to strong ones, require less work and attention to be maintained (Granovetter 1977, 1983). In the case of a network of organisations, weaker ties occur between organisations that do not work together on a daily basis, but are aware of one another and may collaborate occasionally (Granovetter 1977, Provan & Kenis 2008). Such ties may appear e.g. between OEMs in a manufacturing industry network, where most of the time the OEMs do not work together, but are occasionally brought in by the

central organisation to work together on a larger project.

The definitions of a value network and a business ecosystem are upon closer inspection rather similar to one another, but distinct. In their article, Peltoniemi (2004) compare value networks and business ecosystems. According to their review of literature, the main difference between a value network and a business ecosystem is that a value network is a strictly cooperative structure, while a business ecosystem encourages both competition and cooperation (Peltoniemi 2004). However, according to Peltoniemi (2004), there is still some competition between organisations when the members of a value network are selected, as some will be excluded to define the boundaries of the value network.

Both a value network and a business ecosystem are networks encompassing organisations co-creating value across industries, regardless of their physical location (Iansiti & Levien 2004, Lusch et al. 2010, Moore 1996, Peltoniemi 2004, Peppard & Rylander 2006). There are organisations of many differing roles in both value networks and business ecosystems, the core ones being supplier, customer and lead producer (Adner & Kapoor 2010, Moore 1996, 1998, Peltoniemi & Vuori 2004, Peltoniemi 2004). In addition to these, Moore (1998) includes into a business ecosystem other actors that surround the organisations, such as governmental institutions, financing, labor unions, etc. These are typically not included in the definition of a value network (Peltoniemi 2004).

In both a value network and a business ecosystem there is a focal organisation that has more influence over the other members of the network of organisations (Iansiti & Levien 2004, Moore 1996, Peltoniemi 2004). However, according to Peltoniemi (2004), in a value network it is common that one actor is much larger and more influential than the others and that the other members of the network can be utterly dependent on the dominant organisation, while in a business ecosystem power is typically more decentralised. Iansiti & Levien (2004) and Moore (1996) speak similarly, but state that there can be a very large dominant actor in a business ecosystem as

well, but that it can not dictate over the network of organisations similarly as a dominant organisation in a value network can.

Due to the similarities of value networks and business ecosystems, theories related to them can be used for both, if their differences are taken into account. As such, this thesis combines literature about value networks and business ecosystems to study the formation of a value network or a business ecosystem and the challenges faced by its managers.

2.2.2 Formation of an Ecosystem

Keast et al. (2004) and Popp et al. (2014) talk about moving towards working in networks because the problems that the company or companies have to solve are too big for one company. Related to this, Popp et al. (2014) state that whether the network is emergent or mandated has huge influence on how challenging building internal and external legitimacy for the network is. A mandated network is formed based on outside pressure, e.g. legislation, and emergent is formed due to the vision the organisations themselves have about the possible value they could create together (Paquin & Howard-Grenville 2013, Popp et al. 2014, Provan & Lemaire 2012).

Popp et al. (2014) claim that it is common for networks to display characteristics of both mandated and emergent networks. The amount of external pressure towards the formation of the network naturally affects the formation process, and Popp et al. (2014) and Provan & Lemaire (2012) argue that when the network is more mandated than emergent, external legitimacy is usually easily gained and because of that, internal legitimacy is often overlooked, and thus the commitment and internal motivation towards reaching the network goals are weakened.

Whether or not a network is mandated or emergent, Paquin & Howard-Grenville (2013) argue that during the formation of an inter-organisational network, a network orchestrator either emerges or is appointed to guide the process, and the network itself later on. The purpose of a network orchestrator is to assemble and develop the network, to enable a network culture

where relationships between the participants may form, and to bring out the best of its participants (Paquin & Howard-Grenville 2013). The role of a network orchestrator links to leadership in a network, as presented by Popp et al. (2014). A network orchestrator may either be the lead organisation of the network or a separate network administration organisation as defined by Provan & Kenis (2008), depending on the type of governance structure chosen for the network.

Lavikka et al. (2017) argue that the starting point for a transformation from a simple supply chain to a more interconnected digital network or ecosystem of organisations is the already existing pool of organisations working with one another. This makes sense, as these organisations already have ties with one another and a common history, and it is likely that their products or services are already complementary when they move to further digitalise their value creation. This type of a starting point works for both mandated and emergent networks.

Starting with organisations one is already working with is helpful as there is some existing trust between the companies, which is crucial for the success for inter-organisational cooperation (Akkermans et al. 2004, Popp et al. 2014). However, as the transition towards a digital business ecosystem changes the existing relationships and interdependencies between the members of an existing supply chain, the transformation and governance of the transformation phase needs work (Lavikka et al. 2017), and network orchestrating (Paquin & Howard-Grenville 2013). A new collective identity is formed on top of these changed relationships.

Lavikka et al. (2017) state that the transformation towards an ecosystem brought on by digitalisation changes the relationships and interdependencies between the members of an existing supply chain, potentially opening it up for new entrants. This, of course, is a threat to the current members of the supply chain, as new entrants can possess the abilities take on their roles in addition to providing additional value to the network, and can thus displace some of the current members.

According to Russo-Spena et al. (2014) and Provan et al. (2011), there is a certain order in progression in the formation of a business ecosystem or value network. Both consider that first, a shared identity and the relationships within a network need to be formed first, before the actions required towards reaching the network's goals are defined. For this thesis, the theory proposed by Russo-Spena et al. (2014) is used, as they talk about this progression as the different phases. Considering the formation of a business ecosystem in phases gives the possibility of more closely identifying what aspects in each phase are challenging, compared to considering a more fluid progression.

1. **Selection of members.** In the first phase, the members of the ecosystem are selected and their roles and responsibilities are defined.

2. **Shared understanding about goals.** In the second phase, shared understanding about the issue the network wants to solve and the goals the network wants to reach through the collaboration are defined.

3. **Actions towards the goals.** In the third phase, the actions to reach the common goals are defined and responsibilities between the members of the network are divided. Legitimacy of the network is built.

Considering these phases against other literature, it comes clear that these link specifically to certain challenges the network faces. For example, Peltoniemi (2004) considers there to potentially be severe competition between the prospective members of the ecosystem as they compete to be part of the ecosystem and its generated additional value. Additionally, Hardy et al. (2005) consider it crucial that shared understanding about the network's goals is formed for the network to be able to reach its goals. Furthermore, the challenges of networks identified in Section 2.1.1 are strongly present in all these three phases. The links between the challenges and phases are summarised in Table 2.1, with challenges that are prevalent in all phases marked in gray.

Phase	Challenge
Selection of members	Working culture clashes (challenge 2) Loss of Autonomy (challenge 3) Coordination fatigue and costs (challenge 4) Developing trusting relationships (challenge 5) Accountability within the network (challenge 6) Management complexity (challenge 7) Lack of organisational capacity to work collaboratively (challenge 9) Sustainability (challenge 10)
Shared understanding about goals	Achieving consensus on network goals (challenge 1) Working culture clashes (challenge 2) Loss of Autonomy (challenge 3) Coordination fatigue and costs (challenge 4) Developing trusting relationships (challenge 5) Accountability within the network (challenge 6) Management complexity (challenge 7) Power imbalances (challenge 8) Lack of organisational capacity to work collaboratively (challenge 9) Sustainability (challenge 10)
Actions towards the goals	Working culture clashes (challenge 2) Loss of Autonomy (challenge 3) Coordination fatigue and costs (challenge 4) Accountability within the network (challenge 6) Management complexity (challenge 7) Power imbalances (challenge 8) Lack of organisational capacity to work collaboratively (challenge 9) Sustainability (challenge 10)

Table 2.1: Phases of business ecosystem formation by Russo-Spena et al. (2014) linked to challenges of networks by Popp et al. (2014)

Notable about the links of challenges to phases is that the second phase is in fact the same as the challenge of achieving consensus on and commitment to network purpose and goals (challenge 1). Also, developing trusting relationships is most crucial during the beginning of the formation, as the relationships are defined during the first phase, but trust forms over time, and as such, it is marked as more important during the first two phases, although it could go on as a challenge for a longer time as well. The Power Imbalances (challenge 8) are troublesome during the second and third phases where the goals and the actions to reach them are defined, as all of the interests of the different organisations of the ecosystem need to feel like they are heard and their needs are being considered.

Clearing the three phases well contributes towards easing the way of the network to collaboration. Addressing the many challenges makes the network more sustainable (Popp et al. 2014). Defining the relationships, goals and

ways of working towards the goals all add to the ability to hold the members of the network accountable for their own responsibilities and roles in the network. Transparency within the network and measuring the results of the network working together adds to accountability, and makes it easier for the companies involved to commit to the network and feel satisfied in it (Page 2004).

In their case of observing the formation of a business ecosystem, Lavikka et al. (2017) found that when organisations from a manufacturing industry supply chain were brought together to innovate how they could create additional value through digitalisation, this opportunity mainly motivated the hub company or the main production company of the network, as they would gain the most business benefit out of it. Contrastingly, the subcontractors, although had very positive views on digitalisation and gaining new, more accurate metrics for quality, did not see the potential added value for them, and thus were less motivated (Lavikka et al. 2017). According to Lavikka et al. (2017), this dampened motivation seemed to stem from the power imbalance between the subcontractors and the powerful hub company. Thus, shared understanding about the business and possible gains needed to be formed, before the full potential value of the network could be understood network wide (Lavikka et al. 2017).

The combining factor in the whole process of network formation is a *shared understanding* that the organisations need to form together, both about the roles and interdependencies and about the goals and the actions that should be taken to reach them. As such, the ability to form a shared understanding becomes crucial to the business ecosystem in order for it to be able to innovate together.

2.3 Creating a Shared Understanding

As underlined in the previous sections, the cooperation in inter-organisational networks or ecosystems requires the formation of a shared understanding

between the participants of the network or ecosystem. In their work, Carlile (2004) discuss the difficulties of product development within one organisation over the *knowledge boundaries* that exist between members from different departments of an organisation.

Carlile (2002) define a knowledge boundary as a meeting point of expertise from different departments, and that this boundary is both a source and barrier of innovation and knowledge creation. The concept applies also between companies, as the fundamental concept of persons coming from different backgrounds making them not share their view on the matter at hand is the same within and between organisations (Carlile 2002, 2004, Nonaka 1994, Nonaka & Takeuchi 1995). As there are likely even less similarities regarding working practices and little shared syntax and semantic language between organisations, it can be argued that this knowledge exchange to create a mutual, shared understanding is even harder between organisations than within an organisation.

Carlile (2004) explain that there can be three different kinds of boundaries between actors that need to share knowledge with one another with increasing complexity of doing the actual knowledge transfer. These boundaries are in order the syntactic boundary, the semantic boundary and the pragmatic boundary (Carlile 2004).

The syntactic boundary is according to Carlile (2004) the easiest one to overcome, as at that level the actors understand the dependencies between what they are doing and have an understanding about their differences, and can develop a common lexicon or shared terminology to transfer this knowledge from one actor to another. At the second level, the semantic one, there are some differences and dependencies between the actors considering the actions towards reaching goals that are unclear, and it is required for the actors to create shared meaning for the knowledge to be able to then proceed to the syntactic boundary and develop a shared terminology for it (Carlile 2004, Nonaka 1994). At the most difficult boundary, the pragmatic one, the actors have differing interests, which impedes their willingness and capability

to share knowledge (Carlile 2002, 2004). They are required to create common interests before they have the means to assess and share knowledge at the boundary (Carlile 2004).

This is to say that the less understanding there is between the actors that seek to share knowledge, the more obstacles they have towards actually sharing the knowledge they need to share. This further underlines the importance of defining the goals of the network in a way that aligns the differing interests of the companies so that they all have a collective, common interest in collaborating in the network.

Similarly, based on their research on the effect of relationships and social interaction on product innovation, Tsai & Ghoshal (1998) state that a shared vision, which incorporates the goals of an intracorporate network, promotes shared understanding, understanding about each other's roles, and trust between the members in this network. Tsai & Ghoshal (1998) contemplates shared understanding and trust within an organisation, but as their theory is based on the networks of members from different divisions, combining knowledge of different disciplines and coming to work together with different needs and aspirations, their statements about a shared vision of bringing these different members together is applicable to inter-organisational networks as well.

Tsai & Ghoshal (1998) also state that the shared vision contributes towards the formation of a collective identity in the organisation, as it is a bonding mechanism for the participants of the network. This aligns with Saz-Carranza & Ospina (2011) statement that the unity of a network is affected through its collective identity, which is formed through the consensus about its goals. As is further underlined by this, forming a shared understanding is crucial for the network.

2.4 Data Sharing and Trading

When data are handled in a network, it becomes relevant to consider literature about sharing and trading in data, and what sort of challenges and requirements arise from it.

A problematic trait of data and trading in data is that they have weak legal protection in the terms of intellectual property rights (Duch-Brown et al. 2017), which is one reason for the fears towards adapting a new technology, as the competitive advantage gained through the data can not be protected in a guaranteed way (Kagermann 2015, Koutroumpis & Leiponen 2017). According to Koutroumpis & Leiponen (2017), it is due to the fear of data falling into wrong hands and causing the loss of competitive advantage that companies instead choose to protect their data goods via contractual means.

Writing comprehensive, limiting contracts consumes both time and money, making the data sharing far less attractive, and they typically limit the further sharing or combining of the data when it is to other parties than specified in the contract (Loebbecke et al. 2016, Koutroumpis & Leiponen 2017). Data contracts also tend to have contract terms that are heavily tied to the context they were made in, that is, they are specific to those laws, measurement units and regulations of a particular jurisdiction (Truong et al. 2012), complicating further the combining of data that are governed by separate contracts (Koutroumpis & Leiponen 2017).

Trading in data is balancing between the need to have control over the data and the need to share the data. Due to its weak legal protection, sharing data has its risks, especially when it concerns high value or high confidentiality data. However, if the company can not harness their value alone, cooperation of some kind is required, and thus, a balance needs to be found to this tension.

2.4.1 Types of Data Markets

Assuming the need to trade in data, the company or companies wanting to trade in it have to choose between different types of possible trading, depending on their individual situation. The type of trading the network can go for is either one-to-one between each organisation using and creating data, or a multilateral one where data can also be traded between the data creators for further refining before selling to a data user (Koutroumpis & Leiponen 2017). Should the data that the organisations trade in be such that are business critical for any of the organisations, choosing the participating organisations and safe means of trading with data are crucial for the data sharing and trading to be a viable option for the participating organisations (Koutroumpis & Leiponen 2017).

Inherently, Koutroumpis & Leiponen (2017) insist, that when constructing a market for data, it is a trade-off between *data provenance*, i.e. the origin of data, which represents the control over the data and the quality of it, and *transaction costs* of trading in it. In the case of a one-to-one trading arrangement in data, the relationship between these companies is very controlled and the provenance of data can be secured. In case the company wants to trade with many partners, the fixed cost of arranging many one-to-one data trading relationships is high due to the costs of arranging and managing each individual relationship (Koutroumpis & Leiponen 2017). These types of relationships always have high restrictions on giving the data further or combining it with third-party data. Gans & Stern (2010) point out that in markets for ideas, the ability to assess and combine complementary ideas is what often gives them their value, and Koutroumpis & Leiponen (2017) argue that the same is true for data. Thus a **multilateral** marketplace would enable further innovation and value creation than one-to-one trading arrangements would.

In their article, Koutroumpis & Leiponen (2017) construct three different models for multilateral data markets combining the market design models introduced by Roth (2002, 2008), and the governance of common pool re-

sources by Ostrom (1990). These types are centralised, decentralised and collective.

The centralised marketplace is closest to the typical multi-sided trading platform, where there is one marketplace managed by the platform owner, and the platform does everything from dealing with data provenance to payments and aggregation (Koutroumpis & Leiponen 2017, Thomas & Leiponen 2016). In a decentralised marketplace, some of these functions, namely the management of data provenance, are externalised via a decentralised layer, using a distributed ledger technology (DLT), e.g. blockchain (Catalini & Gans 2016, Koutroumpis & Leiponen 2017, Walport 2016).

Koutroumpis & Leiponen (2017) argue that decentralised marketplaces have a lot in common with centralised marketplaces regarding basic attributes, but that due to the usage of the DLT layer, some of the key limitations of centralised marketplaces are alleviated. These limitations include the ability to more effectively and transparently keep control of the provenance of data by providing traceability and requiring authentication (Koutroumpis & Leiponen 2017, Walport 2016).

However, Koutroumpis & Leiponen (2017) also state that the DLT technologies are currently still not at the point that they could be widely used for a decentralised marketplace kind of application. Due to this, they suggest a simpler and more modest version of a multilateral market platform using Ostrom (1990) common pool resource governance principles, and this is what they call a collective multilateral market. In a collective multilateral marketplace, contracts and rules are used to take care of the data provenance issues, but naturally they build a strong boundary for the market and due to the effort of forming these contractual relationships, the market will stay smaller than what a decentralised marketplace can grow to be (Koutroumpis & Leiponen 2017, Ostrom 1990, Roth 2002, 2008).

Koutroumpis & Leiponen (2017) state, however, that in the case of an industry vertical or a stable network with already existing trust-based relationships and clear shared interests might despite its limitations find a

collective multilateral market as significantly value adding. They underline that this is especially the case when high value and highly confidential data are concerned (Koutroumpis & Leiponen 2017).

The central differences of these platforms regarding trading in data are summarised in Table 2.2.

	Multilateral centralised	**Multilateral decentralised**	**Multilateral collective**
Platform type	One centralised platform	Separate trading platform and DLT layer	One centralized platform
Boundaries of entry	Medium	Unnecessary	Strong
Characteristics of Data	Medium value, medium confidentiality	High value, high confidentiality	High value, high confidentiality

Table 2.2: Multilateral market types, adapted from Koutroumpis & Leiponen (2017)

2.4.2 Big Data and Data Quality

Russom (2011) defines Big Data as data with three qualities: volume, variety and velocity. The large volume of data is considered the most defining character of Big Data, as according to Russom (2011), a common expectation for Big Data is to be at least several terabytes in size. However, Russom (2011) underlines that it is important not to ignore the aspects of variety and velocity in Big Data, as those describe that Big Data comes from various sources with various quality and as such, any analytics run on Big Data must be ready to deal with its variety, and the velocity or the frequency of data creation and its analysis.

Companies have been collecting data for years, but it is only with the emergence of Big Data analytics that this data has become business critical, as companies have the possibility to understand what happens in their business and with their customers on a much deeper level than before (Khatri &

Brown 2010, Russom 2011). Naturally, through this, companies have come to realise that data are a valuable enterprise asset that requires governance in a similar way as financial assets do (Khatri & Brown 2010, Russom 2011). Governance addresses the traceability of data, providing structures, policies and procedures that encompass the full life cycle of data (Khatri & Brown 2010). A thorough data governance thus provides the basis of trading in data, as it provides information required for data provenance.

According to Russom (2011), just collecting large volumes of data will not by itself create competitive advantage, but it is with advanced analytics that the data can be refined to create understanding about the business of the company. Understanding the context of the data and what how to read and analyze it in order to gain information is crucial (Russom 2011, Koutroumpis & Leiponen 2017). However, to succeed in leveraging Big Data means measuring the right things in the right way and also being able to rely on the results that the analysis gives, when the operations on it are done (Batini & Scannapieco 2006, Redman 2016).

Russom (2011) claims, that Big Data does not care if the data are of low quality, as long as there is a lot of it. However, others argue that the quality of data matters, and indeed, that its quality is crucial for the quality of decisions that can be made from it (Fisher & Kingma 2001, Hazen et al. 2014, Redman 2016). Following this line of argument, if the data a business uses for evaluating its business and to gain new insights is of low quality and thus can not be trusted, it causes additional work for those who work with it and use it, as they have to spend time verifying the data or by other means working around the low quality of data (Redman 2016). The importance of the issue is made clear especially with arguments like made by Batini & Scannapieco (2006), who estimate that low quality data costs billions of dollars per year for businesses in USA. This makes data quality something that can not be ignored while considering big data and its applications.

While Russom (2011) may be right about the low quality of data not being a huge issue in Big Data in some cases, like they might be when the

analysis mostly concerns changes and trends in data, especially when the data is inaccurate due to high error margins, bogus trends may be flagged as relevant ones and wrong decisions may be made, as Fisher & Kingma (2001), Hazen et al. (2014) and Redman (2016) argue. Based on this, for this study it is assumed that it is not merely enough that there is a lot of data in Big Data, but that this data is also of high enough quality to not be the cause of erroneous conclusions.

According to Batini et al. (2009), Fisher & Kingma (2001), Hazen et al. (2014), Wang & Strong (1996), it is important to note that data quality is not only about data accuracy, but that it has multiple dimensions. The four dimensions that Wang & Strong (1996) define for data quality are the following:

- **Intrinsic quality:** Accuracy, objectivity, believability and reputation of data
- **Contextual quality:** the value the data adds, its relevancy, timeliness, completeness and the appropriate amount of data
- **Accessibility:** ease of access and the security of access to the data
- **Representation:** interpretability, ease of understanding and the consistency and conciseness of its representation

In the definition by Wang & Strong (1996), intrinsic quality shows that data have quality in their own right, while contextual quality argues that data need to be evaluated within their context for the quality of data to be assessed properly. The latter two dimensions, accessibilty and representation, highlight the importance of the role of the systems used to collect, analyse and access the data, presenting a usability view on the quality of data (Wang & Strong 1996).

Combining multiple sources defining data quality, Batini et al. (2009) state that the basic set of data qualities that can be found in all of them are *accuracy, completeness, consistency*, and *timeliness*. Comparing these data qualities to the ones presented by Wang & Strong (1996), only the dimension

of data accessibility is missing. However, the compilation of different data quality studies by Batini et al. (2009) accesibility is often found, although not lifted into the basic set of data qualities they present. Thus in this study, we choose to base our understanding about the quality of data on the metrics presented by Wang & Strong (1996).

Koutroumpis & Leiponen (2017) add that an important part of what consists the quality of a piece of data is its **provenance**, that is, the origin, characteristics and history of changes in the data. Including this type of meta-data with the data adds to the accuracy and relevancy of the data by strengthening its representation by giving more encompassing representation of information about the(Koutroumpis & Leiponen 2017). This meta-data is part of the context of the data, adding to their contextual quality (Koutroumpis & Leiponen 2017, Wang & Strong 1996).

The challenge is that the quality of data is hard to evaluate (Koutroumpis & Leiponen 2017). As the usage and true value of data comes from the understanding gained through its analysis, data by its very nature is an intermediate good that is of lower quality and worth less before it is processed and analysed (Chebli et al. 2015, Koutroumpis & Leiponen 2017). The analysis and combination of data that makes it useful and usable is not visible from the data, nor is the quality and appropriateness of the analysis and combination (Koutroumpis & Leiponen 2017).

2.4.3 Value of Data

To be able to trade in data, a crucial part is forming a shared understanding about the value of the data that are provided, so that the potential participants see the value of participating in the trading in the first place. This, however, is not without difficulties.

As stated in the introduction, the amount of data is exponentially increasing, and an increasingly big amount of it is data not created by humans, but rather by intelligent "things" brought on by the trends of digitalisation and the Internet of Things (Gantz & Reinsel 2012), or as a by-product from a

process that is measured (Chebli et al. 2015). The problem as stated by Turner et al. (2014) is that a very small amount of that data is useful and interesting for companies seeking competitive advantage.

As the previous part implies, all data is not equal in the company's eyes. Naturally, in order to gain advantage in their field and serve their customers better, the most useful data for a company would logically be data about their own and their partners' processes, their customers and their preferences, and the competing products and companies (Porter & Heppelmann 2014, 2015, Russom 2011). This type of data can be collected in various ways: depending on the process, sensors and other monitoring systems can collect data about e.g. production of products, data about customers can be collected via the usage of current smart products and also via mobile and social data, and some data about competitors can also be collected by using the data available online, such as reviews and blog posts about the competing products (Porter & Heppelmann 2014, Russom 2011).

The difficulty of evaluating the quality of data makes estimating their value similarly complicated. As the quality of data can not be inspected from the data, but rather requires deeper understanding in order to be able to evaluate the different dimensions of its quality, especially the intrinsic and contextual qualities, the definition of its value ends up far too easily be based on a guess rather than actual knowledge (Batini et al. 2009, Koutroumpis & Leiponen 2017, Shapiro & Varian 1998, Wang & Strong 1996). As the quality of data *hinges on the contextual usefulness of them*, as defined by Wang & Strong (1996), the value of them is different depending on who is using them. This further makes it harder to objectively define their value.

Another trait of data that makes it difficult to value is that as a type of information good, it is an experience good (Shapiro & Varian 1998). According to Shapiro & Varian (1998), for an experience good, the consumer of it can only value it when they have experienced it. This means that the value of data varies depending on its consumer and that consumer will not be able to fully appreciate the value of data before it has been experienced

(Koutroumpis & Leiponen 2017, Shapiro & Varian 1998).

Due to the value of information goods being difficult to evaluate and prove, trust between the seller and buyer of the data or the data service becomes crucial (Akkermans et al. 2004). The more transparency there is in the process, the less trust there needs to be, but transparency is difficult when it comes to data due to its nature as an information good.

Information goods are costly to collect and produce, but are very cheap to copy, and this low marginal cost of copies is further lowered by the digital form of data (Shapiro & Varian 1998). Data is also easy to spread further, but spreading it lowers its value for the original customer (Koutroumpis & Leiponen 2017). Also, the data may contain trade secrets that could in the hands of competitors, who understand the process, make the original company lose their competitive advantage (Kagermann 2015, Koutroumpis & Leiponen 2017, Porter & Heppelmann 2015).

Due to the quality of data being difficult to define and the nature of data as an information and experience good making it difficult to value before consumption, forming a shared understanding about the value of data between partners in a network is complicated and difficult.

2.5 Theoretical Summary

In this section the findings of the literature review are discussed and summarised and the research problem presented in the introduction is answered as far as possible through the findings from the literature review. Based on these findings, a theoretical framework is presented, and empirical research questions are formed for use in the empirical part of this study in Chapter 3.

A company intending to harness value from data needs to have access to competences for both the collection and analysis of high-quality data in a way that does not mislead them into making wrong assumptions. As discussed in Sections 2.4.2 and 2.4.3, the quality of data and its value are highly dependable from the way the data are collected and analysed.

This means that the company would require the competences for handling Big Data, but if Big Data analysis is not at the core of the company's business, this may not be in their interests to spend money and time on. Instead, they can choose to find these competences elsewhere, either in companies they are already working with or in a new company they have not yet worked with. The upkeep of a Big Data analysis system would require closer cooperation than a simple supply chain would, thus changing relationships between companies partaking in it. By doing this, they would be moving from a value chain towards a value network, or even a business ecosystem, if they choose to include more stakeholders from around them in the network.

A network is a great way to harness the competence of other complementary organisations around the company, but it does not come without challenges. In the following sections, the results of the literature review done into these topics are summarised, and a theoretical framework for explaining data sharing in emerging networks is developed.

2.5.1 Challenges of Data Sharing in Emerging Networks

In Chapter 2, literature about networks, ecosystems, shared understanding and data sharing across organisations has been reviewed, and challenges that are part of the value co-creation in networks or data sharing between organisations have been identified by several authors. To summarise the literature from the point of view of challenges for data sharing, the literature review has been summarised into tables. Table 2.3 on page 54 summarises general challenges found in the management and leadership of networks, and Table 2.4 on page 55 presents challenges of Big Data and data sharing.

Each challenge is presented with a short description and the sources that are relevant to the challenge, and the data sharing challenges are linked to the general challenges in networks, as they are subject to those.

Table 2.3: Challenges of networks

ID	Challenge	Description	Sources
c1	**Consensus and Commitment to Goals**	The differing goals and needs of the member organisations make it difficult to achieve a shared understanding about and a commitment towards the goals the network should be working towards.	Carlile (2004) Hardy et al. (2005) Inkpen & Tsang (2005) Lavikka et al. (2017) Popp et al. (2014) Provan et al. (2011) Russo-Spena & Mele (2012) Russo-Spena et al. (2014) Tsai & Ghoshal (1998)
c2	**Working Culture Clashes**	Member organisations come into the network with differing working practices, and thus forming common structures and processes is a complicated process.	Bechky (2003) Inkpen & Tsang (2005) Carlile (2004) Popp et al. (2014) Russo-Spena & Mele (2012)
c3	**Loss of Autonomy**	Coordinated decision-making takes away some of the autonomy of the organisation, and it is tied to the other organisations in the network via shared fate, which can be difficult to accept.	Gulati et al. (2012) Iansiti & Levien (2004) Kagermann (2015) Popp et al. (2014)
c4	**Coordination Fatigue and Costs**	Cooperation is hard and the coordination of it is complicated, and the time spent on collaboration is away from the other value-producing work the member organisations could be doing, which is a challenge.	Hardy et al. (2005) Koutroumpis & Leiponen (2017) Popp et al. (2014)
c5	**Developing Trust**	Trust takes time to build and must be maintained for the relationships within the network to stay flourishing.	Akkermans et al. (2004) Granovetter (1977) Granovetter (1983) Inkpen & Tsang (2005) Popp et al. (2014) Tsai & Ghoshal (1998)
c6	**Obstacles to Performance and Accountability**	The responsibilities in the network need to be divided so that member organisations can be held accountable for them, and not knowing how other members contribute towards the goals can make cooperating less appealing. Thus, transparency is required.	Milward & Provan (2006) Page (2004) Popp et al. (2014) Russo-Spena et al. (2014)
c7	**Management Complexity**	Management of the network needs to be done across the organisations as well as within the organisations, and this is challenging.	Bechky (2003) Carlile (2004) Milward & Provan (2006) Popp et al. (2014)
c8	**Power imbalances**	Some organisations in the network will have more power and resources than the others, but the needs of all need to be taken into account.	Iansiti & Levien (2004) Milward & Provan (2006) Moore (1996) Popp et al. (2014)

ID	Challenge	Description	Sources
c9	**Lack of Capacity to Work Collaboratively**	Working in a network is very different from working as individual companies, and adapting to collaborating in a network requires learning, which can cause resistance to change within companies.	Coch & French Jr (1948) Lavikka et al. (2017) Popp et al. (2014) Provan & Lemaire (2012)
c10	**Sustainability**	The challenges and complexity of working in a network make it difficult to sustain in an ever-changing environment.	Popp et al. (2014) Provan & Kenis (2008) Provan & Lemaire (2012)
c11	**Resistance to Change**	Adapting new technology and ways of working is hard for the workforce of the companies. It takes time for new working habits to form that make use of the new technology and ways of working.	Coch & French Jr (1948) Kagermann (2015) Russom (2011)

Table 2.3 includes the challenges found in literature regarding the topic of collaboration in networks. These are challenges every emerging network has to face to some degree, not specific just to the data sharing context. On top of these, an emerging network that seeks to create value through sharing data has to face the specific challenges listed in Table 2.4.

The table also presents a hypothesis about how the challenges found in sharing data could be linked to the network challenges found in Table 2.3, as logically it seems that the data sharing challenges that are either part of these network-level challenges, or contribute towards them. As such, in this thesis we consider these challenges to be sub-challenges of the network-level challenges, that emerge in specifically data sharing scenarios, and we test this in the empirical research.

Table 2.4: Challenges of Data Sharing in a Network

ID	Challenge	Description	Related to	Sources
dc1	**Protection of Data**	Data as an information good has weak legal protection, and easily replicated and spread, posing risks to the owner of the data.	**(c3) Loss of Autonomy** **(c4) Coordination Fatigue and Costs** **(c5) Developing Trust**	Duch-Brown et al. (2017) Kagermann (2015) Koutroumpis & Leiponen (2017) Porter & Heppelmann (2014) Shapiro & Varian (1998)

dc2	**Data Provenance**	Data needs to be in context to be valuable and of quality, and its owner needs to keep continuous control over it.	**(c3) Loss of Autonomy** **(c4) Coordination Fatigue and Costs** **(c10) Sustainability**	Fisher & Kingma (2001) Hazen et al. (2014) Khatri & Brown (2010) Koutroumpis & Leiponen (2017) Redman (2016)
dc3	**Value of Data**	Gaining shared understanding of the value of the data is difficult due to its nature as an information and experience good. Value is not easily seen from the data, and the data needs to be analysed to have value.	**(c5) Developing Trust** **(c6) Obstacles to Performance and Accountability**	Akkermans et al. (2004) Batini et al. (2009) Carlile (2004) Koutroumpis & Leiponen (2017) Lavikka et al. (2017) Russom (2011) Shapiro & Varian (1998) Turner et al. (2014) Wang & Strong (1996)

Table 2.4 presents the challenges of sharing data in networks found combining literature about Big Data, IoT and data markets. These challenges stem from the inherent nature of data as an intangible information and experience good, In fact, all of these challenges can be argued to be true to even just a single company seeking to analyse and gain value of their own data by themselves, although some, like the Protection of Data and Resistance to New Technology, can be argued to not be as acute in a situation where the data are planned to stay within the one company. However, between companies, all of these challenges are certainly present, which is the focus of this thesis.

2.5.2 Emerging Tensions in Data Sharing Networks

Challenges are something an emerging network has to overcome in order to be able to cooperate and create value together, while tensions are pulling forces in the network that need to be balanced and that shape the identity and the type of network that it can become. As such, the challenges presented, as discussed earlier in Section 2.1.2, bring with them tensions into the network that the managers of it need to handle. These tensions are summarised in

Table 2.5.

ID	Tension name	Tension Description
t1	Efficiency vs. Inclusiveness in the Network (Provan & Kenis 2008)	Decisions need to be made efficiently, but all the member organisations need to feel that their needs are considered in the decisions that are made.
t2	Internal vs. External Legitimacy of the Network (Provan & Kenis 2008)	Demands of member organisations and external stakeholders need to be considered in the network purpose and goals, and support and commitment for the network needs to be gained internally and externally.
t3	Flexibility vs. Stability of Network (Provan & Kenis 2008)	The network needs to be able to adapt to changes, but its members require stability to feel safe.
t4	Unity vs. Diversity in Network (Saz-Carranza & Ospina 2011)	Unity brings organisations together to work in accord, and diversity of its members bring unique contributions towards the value the network produces. However, unity can bring similarity and diversity disunity.
t5	Sharing Data vs. Controlling Data (Koutroumpis & Leiponen 2017)	Data needs to be shared for its potential value to be harnessed, but sharing compromises the control the data producing or owning company has over its data.

Table 2.5: Tensions in emerging networks looking to share data

Considering these tensions and the challenges presented earlier in Tables 2.3 and 2.4, it becomes clear that the challenges summarised into Table 2.4 are specific to the nature of *data* as the shared resource in the network. Thus, not all challenges contribute towards all of the tensions presented in Table 2.5.

Based on the literature review, links between challenges and tensions are formed, and compiled into Table 2.6. These links are based on how literature described each challenge and tension, and they are a hypothesis of how these challenges and tensions link together based on the literature review.

	(t1) Efficiency vs. Inclusiveness	(t2) Internal vs. External Legitimacy	(t3) Flexibility vs. Stability	(t4) Unity vs. Diversity	(t5) Sharing Data vs. Controlling Data
(c1) Consensus and Commitment to Goals		x		x	
(c2) Working Culture Clashes				x	
(c3) Loss of Autonomy	x				x
(c4) Coordination Fatigue and Costs	x			x	
(c5) Developing Trust	x	x	x	x	
(c6) Obstacles to Performance and Accountability		x			
(c7) Management Complexity		x			
(c8) Power Imbalances	x			x	
(c9) Lack of Capacity to Work Collaboratively					
(c10) Sustainability		x	x	x	
(c11) Resistance to Change		x	x		

Table 2.6: Challenges mapped to tensions

As can be seen from Table 2.6, the presented challenges link to the tensions in different ways. The purpose of mapping challenges to tensions is to see beyond the individual challenges and address the larger tensions that they contribute to and indicate.

In this thesis, the linking of the challenges and tensions as presented before is used to analyse the challenges and tensions present within the in-

vestigated emerging network. Notable here is that Resistance to Change (c11) and Sharing vs. Controlling Data (t5) are transformative in nature, meaning that they appear because the network is forming or going through a change, and they do not similarly appear in stable networks.

2.5.3 Empirical Research Questions

The aim of the empirical research is to apply the theoretical concepts to analyse an emerging case network, that is considering to share data and becoming a digital business ecosystem. What are the challenges and tensions in this case? How can they be identified and explained using the theoretical concepts?

To investigate the theoretically defined challenges and tensions in emerging digitalising networks, the following two empirical research questions are formed:

> **RQ1: What challenges and tensions do the managers in the emerging network's companies perceive in transforming their supply chain into a value network that would share data?**

> **RQ2: How do the managers in the emerging network's companies feel these challenges could be overcome, and the related tensions could be balanced?**

RQ1 aims at understanding what sort of challenges and tensions they perceive in transforming their supply chain into a value network that shares data, and RQ2 is seeking to find what they think are the ways to mitigate these challenges and how the problem of data sharing in an emerging value network should be addressed.

These research questions are used in the empirical study of this thesis as well as to answer the research problem of this study.

Chapter 3

Empirical Study

In this chapter, the empirical study of this thesis is described and presented. First, the case chosen to study in this thesis is described in detail.

3.1 Case Description

To gather knowledge about the managerial perceptions of data sharing in existing manufacturing industry networks, a network of companies was chosen that had already been doing business together in the manufacturing industry, but who were looking to expand their business into creating a digital business ecosystem, where they would share data to create additional value for the network.

In this case, collecting data was nothing new to the companies. The factory and its production lines had been equipped with sensors since from over twenty years back, and the data from them had been collected and stored in a data bank. The transformation towards this type of data collection had happened along the advancements of digitalisation, with each part in a factory that had been changed, the new parts had been equipped by their Original Equipment Manufacturers (OEM) with sensors to gather data about the production process.

These sensors would take measurements within the process to make sure

that the parts would be working according to their specifications, and they would also be used to check that the measurements taken were within limits to assure the safety of production and the quality of the product. These sensors, depending on the type of product, take measurements several times second each, twenty four hours a day, and just one production line can have over ten thousand sensors these days. This sums to an enormous amount of data on a daily basis, and collecting and analysing it can be categorized as the collection and analysis of Big Data.

The OEMs that are part of the manufacturing company's supply chain have typically more knowledge on the individual parts they provide than the production company or its maintenance does. They are the ones installing the sensors to be able to give guarantees about the life cycle of each part they provide. They are already rigorously testing their products and they also know about the collection of the data and on its analysis. If the knowledge of the OEMs and the understanding about the process the manufacturing company has could be combined, and the data the manufacturing company owns by means of contract for the individual parts it has bought from its OEMs could be properly harnessed, the manufacturing company could gain additional savings in productivity and understanding about its processes, which it can use to improve them. The OEMs supplying the parts can be competitors to one another, if the parts they supply are substitutes to each other, but it can also be that the parts or software they provide are complementary products, and they are not in direct competition with one another.

These companies were at the time of starting this study completing a 1,5 year research project, where they were with some other companies in a technology-first approach looking for possibilities that the data, that these companies already held, could be used to create new business value for all the companies involved. The type of network formed by the research project was a mandated one, as a certain amount of organisations and their financial contributions were required for the project to run, and the setting mandated

the involvement of the organisations to a degree. The project was not able to deliver results of magnitude due to problems such as a missing common business case and wasted time and resources on issues with NDAs with both the researching organization and all the project participant organizations.

The research project was intended to provide proof-of-concepts for the networks to make concrete what data sharing in the network could do, but the conclusion was a proof-of-concept using data only from the core company of the network, due to problems of getting the data from the other participating organizations and the time for the research project running out. As such, the network as a whole was unable to contribute to the creation of value, and was unable to get value for themselves, with the exception of the core company, that was able to use the proof-of-concept for insight in order to continue work with the research organization, choosing to for the time being leave out the other members of the network.

ID	**Organisation**	**Position**
DC	Data Company	Supplies the databases currently in use at the factory. Many of the equipment parts used in the factory also use the motors they manufacture.
MC	Maintenance Company	Provides maintenance of the factory as a service to the Core Company.
CC	Core Company	Owns and operates the factory.
ASC	Automation System Company	OEM that has supplied the automation system to the factory, which all of the equipment in the factory has to connect to.
VMC	Valve Manufacturer Company	OEM that supplies mainly valves to the factory

Table 3.1: Business Network Partners Involved in Case

It is in this situation that the research is conducted, with observations done during the ending phase of the research project and interviews done two to three months after the project had finished. Three members of the network were chosen for further interviews, based on their existing and possible roles in the network. Of these companies one was the core company, who owned the

factory and produced most of the data, one was the maintenance company of the core company, that is also owned by the core company, and one a company that supplied some of the software and the databases for the core company to manage the data they acquired, and for other customers of theirs also provides data analyzing services. From now on, these companies will be called Core Company, Maintenance Company and Data Company. All of the companies involved in the business network are listed in Table 3.1, and the other organisations involved in the research project are listed in Table 3.2.

ID	**Organisation**	**Position**
RO	Research Organisation	Leader of the research project, not otherwise involved
TC	Telecommunications Company	Telecommunications organisation that was observing the research project, not otherwise involved

Table 3.2: Other partners in the research project

An important aspect of the history of these three companies is that the Data Company had been a previous co-owner of the Maintenance Company, before the Core Company bought all of the Maintenance Company for themselves. In their current configuration, the Data Company did business with mainly the Maintenance Company when it came to supplying new parts to replace the failing ones at the factory, and with the Core Company when it came to providing software or larger projects to benefit the efficiency of the factory and its production lines.

As stated before, some changes brought by digitalisation were already present in the business network relating to this factory: the production line, with all of its parts provided by different companies, collected sensor data into the data storage provided by the Data Company, and the Maintenance Company used this data to actively react via warnings sent by the system to faults in each production line. However, further than this, in the previous research project and this study the possibilities to change or even disrupt the business they could do together through digitalisation were investigated,

as the companies were already actively looking for possibilities to further enhance their business processes and selection of services and products provided through digitalisation and especially the use of Big Data.

The types of data marketplace as presented by Koutroumpis & Leiponen (2017) that were discussed during the research project as potential marketplace types were a multilateral collective data marketplace and a decentralised marketplace via the use of blockchain as a DLT. However, as stated by Koutroumpis & Leiponen (2017) as well, the research project recognized that the DLT were not advanced enough to be used for the type of data sharing required for the network at this point, so although the thoughts about the decentralised marketplace were entertained for the sake of research, the multilateral collective marketplace was the form of data marketplace the research project was actively working towards.

Looking for these possibilities in the context of the research project was specifically driven by the Core Company, as its production line experiences frequent interruptions in production, and as their current maintenance system only reacts to states instead of predicting them, these interruptions are not foreseen, nor are the machines able to be run down in a manner that will not potentially harm other parts of the machine, and cause as little waste in time used in production as possible. The biggest aim for the Core Company was and is to improve its time efficiency, meaning that the production line would be producing as much of the time as possible, and unplanned interruptions of production could be eliminated.

In their whitepaper arguing the major benefits and opportunities of Industrial Internet, Evans & Annunziata (2012) estimate that even 1% increase in efficiency or 1% decrease in energy consumption for a factory such as a pulp and paper mill, energy plants or steel mills would bring profit or savings over 15 years in tens of billions in nominal US dollars. That is, there is obvious value at least certainly for the Core Company for any Industrial Internet applications created with the shared data, if the efficiency of their factory could be increased through it.

During the research project, some ideas about the value the other members of the network could gain were also presented, but as the results of the research project were meager, neither the obvious value the Core Company could get, nor the value the other members of the network might gain was realized. This was very similar to the starting point in the case by Lavikka et al. (2017), where a missing shared logic of being in the same digitalised ecosystem for that type of manufacturing industry and power imbalances between the member organisations dampened the motivation of other companies than the hub company to work towards forming a digitalised ecosystem.

During the beginning phases of this study, the researcher was present in three of the workshops and meetings of the study, participating in formal and informal talks about the research project to find out more about the companies taking part, the research project and the potential in the network. The participants of the project agreed that the biggest obstacles within the research project were the time and personnel limits it experienced from the Research Organisation's side, and the complexity brought by the difficulties of drafting suitably extensive NDAs and contracts for the companies to be able to share any data at all within the project. The personnel deficit and contractual difficulties were unforeseen obstacles that were underestimated or unexpected by the research project personnel.

The positive outcomes that were stated by the participants of the research project was establishing the network of connections between these companies that enabled communication about potential value within the network. Until the date of the publishing of this study, no further research project has been conducted including several of the network members. Another research project started that involved the Research Organisation, the Core Company and by association the Maintenance Company. However, this research project does not seek to provide value to the network other than the two members stated before, even though during the ending phase of the concluded research project it was stated that doing business within this network would create value for the whole network.

This Master's thesis study was conducted as a continuation on top of the concluded research project in order to empirically study the challenges of data sharing in an emerging manufacturing industry network.

3.2 Data Collection and Analysis

In this section the methods of this study are gone through, beginning from the type of study carried out and continuing into the research methodology.

3.2.1 Data Collection

This study is a qualitative case study, with one case chosen as the one to be observed. The case context of this study is explained further in the previous section, and the chosen research approach and scope in Section 1.3.

The data for this study was collected in two ways: observation and thematic interviews. Observation was done in three workshops and meetings, of which two meetings at the Core Company with members of the researching organization and Maintenance Company were also present were recorded and analysed. For the other workshops, notes were made about the topics discussed and the interesting points that were made by the participants. In addition to that, one workshop arranged and videographed by the Research Organisation was analysed as observation material. Table 3.3 lists the dates of observations and a short description each, including a mention of how many of which organisation's members were present at the observed meeting or workshop.

The workshops that were not recorded happened at the very beginning of this research conducted, and as such they were mostly used to familiarize the researchers with the case and the companies involved. The following meetings were recorded for use as observational data, and video material from the workshop on the final day of the project was acquired for the same reason, but the main data of this research remains the interviews conducted, which is merely supported by the observational data collected from the workshops

Table 3.3: Observation Workshops

ID	Date	Description	Participants
WS1	9.10.2017	Meeting about research project results at CC's factory. Audio recorded.	CC x 6, MC x 5, RO x 3
WS2	19.10.2017	Final workshop of research project at RO. Videotaped.	CC, DC x 2, VMC x 2, RO x 9, TC
WS3	30.10.2017	Meeting about research project results at CC's headquarters. Audio recorded.	CC x 7, MC x 5, RO x 4

CC: Core Company, DC: Data Company, MC: Maintenance Company, ASC: Automation System Company, VMC: Valve Manufacturere Company, RO: Research Organisation, TC: Telecommunications Company

and meetings. The workshops, meetings and interviews were all conducted in Finnish, and the material presented here is freely translated into English by the researcher, but all of the material and notes were made in English, with the exception of the codes used for coding the interviews, which were given English names from the start as to better link them with the theory already gathered for the research.

The observation material was mainly used to form an understanding about the research project, and what the roles of each company had been in said project. Insights from the material were used to form the research conducted, and the scope of the study. Additionally, the material was used to add to the points noted from the interviews, and to create additional insight about how the different members felt about the subjects.

The type of interviews conducted were individual thematic interviews, as introduced originally by Merton et al. (1956) and refined by Hirsjärvi & Hurme (2000). A thematic interview is a semi-structured interview technique, that instead of details focuses around the themes the researcher has chosen (Hirsjärvi & Hurme 2000, p.47–48). According to Merton et al. (1956), in a thematic interview the researcher knows that the interviewees have experienced an event or a phenomenon, has done research into the subject of this event or phenomenon, and has based on this analysis come to certain expectations about the defining aspects of the event or phenomenon to

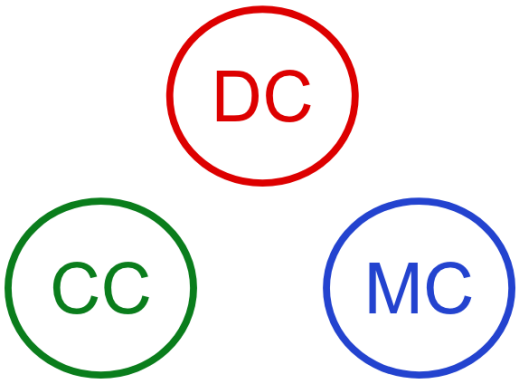
the interviewees. Based on this analysis and the formed expectations the researcher forms an interview framework, which the researcher uses in the interview to direct the interview to the studied person's subjective experiences about the pre-researched event or phenomenon (Merton et al. 1956). Thematic interviews take into account that persons interpretation of things and the meanings they give to those things are important, and that meanings are created in interactions between people (Hirsjärvi & Hurme 2000, p.48).

Following the guidelines of Merton et al. (1956) and Hirsjärvi & Hurme (2000) and the abductive inference logic that was chosen as the method for this research, to prepare to conduct thematic interviews, research into the subject was done. This was done both through the literature review into the subject of Big Data, data sharing between companies and cooperation in a network, and familiarising the researcher into the case through the early observations, investigation into the ongoing research project this case was chosen from, and by interviewing the project manager of that project. Based on the understanding formed through this research, a framework for the interviews was comprised.

The interviews comprised of two parts and in total four themed questions prepared beforehand, three of them belonging into the first part of the interview, and the final into the latter part of the interview. The first part of the interview went broadly into the topics of digitalisation and the changes the company of the interviewee has experienced through it, and approached the topic of forming a network through talking about what collaboration and cooperation they have already done with other companies. In the second part, a boundary object presenting a simplified network of the three companies involved in the interviews was presented, and the interviewees were invited to talk about how data could be shared to create value in this network, with the possibility to add or remove members if they felt that would be for the best. The original boundary object template that was brought into all three of the interviews is presented in Figure 3.1.

In their work, Paavola & Hakkarainen (2005) state that boundary objects

Figure 3.1: Original Boundary Object Template



can either be collaboratively created, or serve as catalysts for co-creation. In this thesis, the boundary objects are collaboratively created, with the researcher bringing into the interview a plain template of the network, and based on the conversation sparked by the boundary object, changes are made to the boundary object and the answers to the interview questions related to the boundary object are drawn onto the object. A separate template was used for each interview. It is important that the interviewees have the chance to question and challenge the prototype, as an unchallenged boundary object hinders collaborative, innovative knowledge creation (Levina 2005), and in this case an unchallenged boundary object would mean that the interviewee's opinions would not be captured in it. How well this realised is analysed in Section 5.3 as part of the evaluation of the impartiality of this research.

Due to the nature of the interviews as thematic interviews, they were semi-structured and did not follow a precise plan of questions. The structure for all of the interviews of the topics covered, translated from Finnish to English, was the following:

1. What does digitalisation look like from your and your company's point of view?
2. What sort of changes have been done due to digitalisation in your company?

3. How have you been working together with other companies, using digitalisation?
4. How would you in the future create shared value in this [boundary object] network through sharing data?
   (a) What sort of value would you create?
   (b) What of challenges do the companies need to overcome before this would be possible?

The companies to interview for this case were picked on based on the previous observations made in the workshops and meetings. From the start, it was obvious that the Core Company and the Maintenance Company would have to be included due to their special positions in the network and their close working relationship, but the choice of which other participants to include was more up to debate. Finally the Data Company was chosen due to them being the one who had provided the network with the database all the data was stored in, and their central role in the research project in cooperating with the Core Company and Maintenance Company in providing the required data for the research team. The interviewees, their respective organisation and position in said organisation are listed in Table 3.4.

ID	**Organisation**	**Position**	**Interview Date**	**Interview Length**
DC1	Data Company	Strategic Business Innovator	30.11.2017	01:43:20
MC1	Maintenance Company	Project Manager	14.12.2017	00:55:41
CC1	Core Company	Quality and Development Manager	04.01.2018	01:17:56

Table 3.4: Interviewee details

Additional interviews were considered, but due to time constraints and extensive data acquired from observations before, the three interviews conducted were decided to be comprehensive enough to provide a broad and

relevant look into this specific case. This was further supported by the interviewees from the Maintenance Company and the Core Company stating that the standing of the other members of the network, providing software and hardware for the Core Company and Maintenance Company, could for most parts substitute one another, although several for them would be needed for the final network.

For the first interview, in addition to the researcher, also the supervisor of this study was present. For the other two interviews, only the researcher were present. All three interviews were recorded in order to ensure the objectivity of research and also to not leave the observations to the memory of the interviewers.

3.2.2 Data Analysis

Analyzing the interviews was started with listening to the tapes altogether, after which the interviews were transcribed by hand into Microsoft Excel. After the transcription of all interviews was done, all transcripts were read again, and short notes were made for the relevant points of each interview into Microsoft Word.

Based on these notes, some tentative codes to be used in the coding phase of the analysis phase were created in order to have some existing structure when going forward. The initial codes, as well as the ones that were used in the final labels, can be found in Table 2 in the Appendix A, marked as an initial code, as opposed to an emerged one that was found during the coding process. In addition, some codes were added after another review of the theoretical framework. These are also marked in the table.

From Microsoft Excel, the transcribed text was transferred into Atlas.ti, where the analysis continued with coding relevant sections of the interviews. The list of initial codes was used as a reference during this stage, and additional codes were added where necessary. 20 of the 21 initial codes were used during the coding process. The only code not used was `big data: possibilities`, as the possibilities that big data brought were all examples

of value creating applications within the network presented in the boundary object, and thus labeled under `bo: value`. Code `dig: facts` was during linking merged with `dig: current state`, as `dig: current state` encompassed both.

34 codes were used during the first round of analysis of the material. After the first round of analysis was done, it became clear that the theoretical knowledge that had been thus far acquired would not be enough to draw deeper conclusions out of the data and their labels, so another round of literature review was done, during which the final theoretical framework was constructed. This framework was then applied to the empirical material through another round of analysis by creating codes for the types of challenges and tensions identified in the literature review, and going through another round of analysis of the acquired data with the new perspective gained from the further literature review. The final amount of codes used for data analysis was 53, not counting `big data: possibilities`, which was already disgarded earlier.

It is important to note that in the first round of analysis, the challenges perceived by the interviewees were simply marked as challenges, and the further analysis of the type of challenges based on the theoretical framework was done in the second round. It is also notable that this second round of analysis included labeling into both network challenges, tensions and data sharing challenges, instead of splitting network challenges and tensions into one round and data sharing challenges into another. The connections between the network challenges and tensions and the data sharing challenges were further explored during this data analysis process. The connections found were used to test the hypothesis made in Chapter 2 of how data sharing challenges and the network challenges might link together.

3.3 Empirical Findings

To be able to draw accurate conclusions about the research, it is important to classify the case context as it is in reflection to what the literature study revealed.

3.3.1 Digitalisation as an Opportunity

Based on the interviews, all three representatives saw digitalisation as a core factor in their current business and its development. Digitalisation was foremost seen as an opportunity to expand business and improve current processes.

> *CC1: ... based on the time I have spent in this job and had to spent working hours on digitalisation, there are a lot of possibilities. I feel that in our processes, in process management, I feel in our factory's view there is a lot of potential, and I believe the same potential can be found in other CC factories as well.*

> *MC1: Naturally it (digitalisation) is very present (in MC's business) these days. From my own projects, we have been building mobile applications, those are purely digitalisation, we have this mobile interface to SAP. ... And of course everything having to do with master data, like now we have done projects with data processing, and that has been attempted to better for years already.*

DC1 also saw digitalisation as a threat in the sense that a company can fall behind.

> *DC1: I have quite a short perspective from DC, but let us put it this way that DC and all its major competitors have the focus of their operations in digitalisation, because from that it is believed*

> *that can be gotten better business and more profitable business. Also one has to be involved, because everyone else is, and one probably does not want to end up in a situation where the others have a much more profitable business.*

Notable was that all the interviewees recognised that digitalisation changes competition, and especially that it moves companies from producing products towards producing services. MC's whole business is providing maintenance as a service to CC.

> *MC1: And we deliver them (CC) maintenance service. We have promised to take care of CC's maintenance, period.*

CC1 recognized that one of the OEMs may take over the business of another's, should they be the one to figure out the right way to analyse the data.

> *CC1: And then what the roles are here with these guys (pointing at ASC and DC on the boundary object), how good know-how they have, it can be for example when we talk about the vibration of some equipment, because it is a mechanical equipment, it rotates, and it causes certain vibration.* ***It is likely that all of them can have the same thing, not caring who supplied the device.*** *It is just that, who can raise up the flag that hey, you need to pay attention to that point now, there's something abnormal there. It is not close enough to this normal state here.*

3.3.2 Network Composition

First, we consider the ten questions to evaluate the necessity of a network as outlined by Popp et al. (2014). The identified problem is beyond the capacity of any one organisation and an complex issue, as the complexity of the manufacturing process and all its parts, their dependencies and the

data that their sensors produce is too large for one organisation to handle. The stakes are moderately high, as the breaks in production are costly for the manufacturing company and all of the members of the network are also feeling the push of digitalisation towards IoT and Big Data. The companies also feel that they will require long-term collaboration to solve these issues, and they have an existing relationship through the supply chain that has existed before. Traditional methods have also been tried. These factors have caused the organisations to already take part in the research project that was concluded during the time of starting this study. The summary of the evaluation can be found in Table 3.5.

Is the identified problem beyond the capacity of any one organization?	Yes, the factory is large, requires a lot of parts and produces a lot of data
Is this a problem or issue where the stakes are high?	Yes, for the Core Company breaks in production are expensive and digitalisation is a threat for all
Is the issue complex?	Yes, understanding the data a factory line produces requires a lot of different expertise
Have other traditional methods already been tried?	Yes, and a traditional value chain or working alone does not work
Is it likely that a common aim could be identified and agreed to?	Yes, a common general aim can be identified and agreed to
Do the organizations involved have similar cultures and values?	Unknown, to some extent yes, especially between the OEMs and between the Core Company and the Maintenance Company
Is there enough diversity among potential participants to provide multiple perspectives on the problem?	Unknown, at least there is enough perspectives to get started with

Is there a history of trusting relationships among the organizations that would comprise the network?	Yes, the members of the organizations have gotten familiar with one another through the research project and previous work together
Will there be the necessary resources to develop and implement a network?	Yes, the companies see digitalisation as the future and are willing to invest heavily if results can be expected
Is the issue one that will require long-term collaboration?	Yes, as more value can only be found through continuous collaboration

Table 3.5: Evaluation of Networks as the Form of Organisation for the Empirical Case

In addition to the necessity of the network, it is important to consider the attributes of the network that affect what challenges and tensions it faces and what capabilities it has to solve them. Popp et al. (2014) listed that the three main factors for this are network governance, network structure and management and leadership of and within the network. Currently, there is no real business network that would exist between the organisations, but rather, they act in a supply chain, but some traits can already be seen through the network that the organisations were trying to form through the previous research project.

Regarding network governance, the supply chain is heavily lead by the Core Company, which holds more power in the supply chain than anyone else. That the situation is currently so was not questioned by the interviewees, and CC1 and MC1 did not express anything that would point towards doubting that position in the future either.

DC1, on the other hand, even questioned CC's role in the network, and whether they would move to be the focal firm or orchestrator of the network, or if they should have another company do it while staying only the producer of the product and product services.

DC1: If CC wants to stay in business, if, let us say it so that if

they want to stay there in the product and product services, and that is their business and they do not want to get out from there, then it is quite smart to give it (coordinating the value chain) to some other actor, that could be ASC or DC, but then if they want to expand their own operations and do it like basically as services, then after that CC would be the one who would in this value chain be in the coordinator position, so that can be a tight competition, that which of those three can get into that position, and it would likely be for all those three desirable.

What was questioned by all of the interviewees, however, was what other companies should be part of the network, and what their roles would be in said network. Regarding this, the interviewees had radically differing views. DC1 saw ASC's role in the network as invaluable, and MC's role as less important, even discardable.

DC1: I think it makes sense for everyone to create business in that environment. I reckon that in the weakest position here is MC, because a general note about that is that when CC... Actually, ASC is missing, it's missing the collection of data done by ASC.

On the other hand, MC1 and CC1 saw CC and MC as inseparable, and the other companies in the network as almost interchangeable, with a note that it would be unviable to just work with one or two of them, but rather a couple of OEMs would be required for the data sharing and the value network to work in a sensible manner.

MC1: As for common projects, since we are practically one of CC's divisions, basically the same company, although there is the company line in between, we do all of this together.

CC1: I would see it that way that this row (referring to DC), that there are several companies here. But it's these days when

the organisation is like this, that we have the so called mother company, and a maintenance company called MC, and they can't be separated.

MC1: ... You could put VMC there (in the stead of DC) and it would be the same.

As for ASC, MC1 agreed similarly to DC1 that they would have a special position in the network, but CC1 was not of that opinion, instead listing them amongst all the suppliers CC would work with.

MC1: I would not put ASC there (referring to similar position as DC)
R1: Do they have a smaller role?
MC1: A different role. These two are more part suppliers (DC and VMC). ... (ASC) more of a supplier of automation systems.

CC1: I would put Supplier A B C D here. (referring to similar position as DC)
R1: ASC etc.?
CC1: [hums in agreement]
R1: Are they completely interchangeable?
CC1: I do not know if they are interchangeable, we need to operate with everyone.

It is also worth noting that CC1 and MC1 thought that several of the OEMs would need to be worked with in the value network, whilst DC1 thought that one of the OEMs could take over the role of all the OEMs, and also the role of MC, as MC does not create or analyse data, but rather, they would only use the data provided by other companies.

DC1: This is private thinking, but this type of actors like MC, they have it really challenging, because ASC and DC, we are both strong competitors, ...

- -

R2: So, in your view, you see that in the future there would be no MC?
DC1: Let us say it this way, that I have a hard time seeing what its added value would be.

In the interview, DC1 brought up the topic of taking the customers of CC also involved into the platform, and in the two other interviews the topic was breached by the researcher as the interviewees did not think to include the customer chain even when prompted about who else could be involved in the value network. All of them agreed, however, that there would be some potential value for CC in including the customers in the network.

DC1: It is astonishingly often forgotten to ask the customer that what they want? It would be the quickest way to find out what would be worth doing and in that way start producing services that benefit the customer. And then services that benefit the customer's customer, and extend the action chain further and further in steps when understanding gets better.

R1: What I would be interested about is that what if CC's customers would be involved in this? What sort of information or data could be gotten from them, or wishes, or other that this, that they could be created more value to in this ecosystem.
MC1: In our view, from MC's view, not much probably, because we are taking care of the equipment, CC is driving and CC does the quality. Now when talking about quality, that is a whole other thing. So if now there would be CC's customer who would tell that with this quality we have good runnability, and now that this batch came in from you this one has problems, so if this information would flow between here. So now our data and the runnability information we would get from here, or typographical information, depending on what each customer has as their main criteria, so

> *if these systems could see each other, then we could immediately say, that if here (with the customer) there are problems in typography, we will go look here (CC) what has changed, that it has caused that the color does not stick anymore, or something else.*

> *CC1: (talking about quality faults within the produced product) But if we could get the whole chain managed, that with this big machine, where we make the big carpet, we would not have to discard the small carpets from it, but instead we would do a limited amount with customers, that we have some kind of a transparent enough system, that we both sides could be sure that we have a win-win situation, and it would be priced, it would surely be the best option for the whole.*

As can be seen from these findings, the representatives of the three companies already had very different views on many aspects of the network. This is an indicator of missing shared understanding about the network between the interviewees. Especially striking was the difference of DC1's views on the network structure compared to MC1 and CC1.

3.3.3 Data Sharing Challenges

Diving into the challenges the interviewees perceived between the organisations forming a value network, most of them dealt either with communications and a common goal for the network being complicated, the added value of the data or the services done on it being difficult to define, and sharing data being a daunting task to undertake in fear of it leaking or due to it simply being something that is difficult to do. To further dive deeper into the hindrances they perceived in the cooperation, I present the different aspects of complications they voiced.

CC1 perceived that a big factor in making cooperation harder is the knowledge management within organisations, as it also affects the way the organisations are able to communicate and cooperate with one another.

> *CC1: We just have to have enough understanding, ... that what is the problem and who is affected by it, who are the stakeholders there, and who, from whom we should get input regarding the content, that is an internal thing. And after that from the other side (another organisation) the one who can give the response to that... That we have this kind of a problem, you bring the solution and then, after that it is collaboration, communication. Communication is in that, like in many things, what is not working. We have information here, we have information there, but that information is not communicated further, so it never aligns.*

Similarly, DC1 recognized that there are troubles in communication, especially between individual persons that have different backgrounds, either working in IT or OT, causing clashes through the lack of understanding.

> *DC1: Now there is like, marrying IT and OT together is the biggest thing. That there two cultures, in which people think completely differently, collide. And neither one does not really want, that I do not want to say that I do not understand what the other person is telling me. That I am smart and I am a great guy and I know what I am doing in my own field, but neither one wants at the boundary to show that I do not understand what you are talking about at all.*

CC1 had a similar point to DC1, but they did not say it as something related directly to the presented boundary object, but rather as a general statement about this type of collaboration.

> *CC1: I have seen that, there was last year a project with one in the frame of digitalisation and... No matter how we were talking in Finnish, we did not understand each other in the end. That the difficulty was that we understood how the manufacturing processes work, but you as a supplier did not understand that, and we did*

> *not understand the service you were bringing, that had to do with this machine learning, so we just simply did not understand one another well enough.*

DC1 expressed concern about having common goals within the network, if CC is stuck on a very simple business case and does not see further than that.

> *DC1: So conversation is really hard to have when their business case is there, that let's take some maintenance days away, that if we get them from eight to for example four in a year, it is good for them, it is several hundred thousand euros, saved there.*

CC1, on the other hand, was more concerned about the business cases being hard to sell even within a company due to the fact that services are difficult to value and their value is difficult to prove, and thus getting the initial investment from the corporation on something that they do not know what value they will get out of is hard.

> *CC1: It is easier to say that if you buy some ensemble of equipment, you very concretely know what you are buying. But here too, if you buy something, it surely needs some hard drive space and software that data is transferred with, so there has to be a way here, and that costs something... I guess it is concreteness, but what is really gotten out of it? That what are the measures, what are the KPIs under the total efficients that it can be stated that it is surely useful, that is in my opinion the difficulty there, that how do I argue this, that give me this amount of money that I get someone to do this project for us. And that we get these and these things from it. That is what, what are the these and these things and how do I prove them.*

Similarly, CC1 makes a point about how an idea that would require moving data due to a lengthy value chain is likely more complicated than it would

seem, and at this point, none of the companies involved would exactly know how to go about it.

> *CC1: But there are many obstacles on the way, it is not as straightforward as here (referring to the boundary object)... On the level of a thought everyone likely accepts it, but there are many steps to take, that how the end, how the last of this customer chain, not the consumer but the last supplier or manufacturer, how the information gets there, there are many steps between there.*

Something that both DC1 and CC1 expressed concerns about was that the extensive contracts that they have to form at the current stage slow things down considerably and complicate data sharing within a network of participants. CC1 was worried about the previous contracts making forming new contracts or new business with new partners difficult, whilst DC1 summarised that in the previous research project they had learned that having lawyers discuss contracts made innovation and getting started with working together hard, if not almost impossible.

> *CC1: How, when we have in a way made with DC the supply contract of some sector, and there are some contractual things, then how can we hand over the information to a third or a fourth party.*

> *DC1: Especially a general statement was (from the research project) that, if we let the lawyers discuss this, that where is the business, then there will be no business.*

Both MC1 and DC1 thought that the biggest concern CC has about data sharing is their data being leaked to their competitors, and them being able to derive trade secrets from it.

R1: What is here like, the biggest challenges or problems that this optimum situation, it is not reached, or why, well, why it is in five or ten years?
MC1: Being afraid of the information leak. That is likely the biggest risk. CC opens their process information to DC and through DC they leak to CC's competitor, for example. I believe that is the biggest risk.

DC1: For our customers it makes no sense to give up their most valuable data for free to all other parties, and that is the biggest obstacle, that how can we convince them that hey, they will not in any case be subjected to something like their production processes or formulas accidentally going to a third party.

CC1, on the other hand, when questioned several times about the concerns, did not raise the topic of data leaks as something that CC would be concerned about. Instead, they recognised that they may not be the only ones reluctant to share data, but that on all sides sharing data is something that companies might not be willing to do on the extent that would be required.

CC1: And then another thing is that how much we each party want to open our own Pandora's box, that how much we want *to share data, that is in my opinion another thing, that we will surely not into that kind of a situation, will we ever reach that (situation) that is drawn (on the boundary object), but some good examples would be good to execute, pilot-like and to look, to take things forward, that could this be a success.*

DC1 was concerned that in this situation and in general, companies seeking to utilise data do not know the usefulness of it, and as such, try to go the easiest way instead of trying to find out how and what would be useful for them.

DC1: And that data management seems to be in companies terribly similar, first we take what information we have easily available, and do not analyse what data would be needed to improve our processes. So that is also something that is good that we would first find out what would be useful for us.

3.3.4 Advancing Factors of Data Sharing

To balance out the challenges the interviewees perceived, they both with and without prompting spoke about the factors that in their opinion make moving towards a data sharing value network easier.

One theme that repeated throughout all three interviews was that going at the problem in steps or by trying out a smaller sector of the whole first like a pilot would make the transition easier. DC1 and CC1 saw that creating a small success would make the companies more eager to continue on the same path, as they would know better what to expect and have the trust that going forward would be beneficial for them.

DC1: Actually, that is also an observation from that research project, that there inside the project it would be good to create a small success right beforehand, or right up front. That it would be checked that some things would succeed. It does not matter if they succeed or not, but then there would be a shared understanding and platform about it, and then when beginning to work towards a common goal, how could the problems be solved that we could not immediately solve like we thought we could.

CC1: And not the whole thing that... It just has to be at some point, to open that door and go to start doing something a little, and if it is found to be a good thing, then it will start expanding, the pull of good experiences further expands it, even that field.

MC1 underlined that most of these projects could very well be done in different steps, but value to the companies might come differently in the

different steps, with the most valuable for every company involved being the highest level.

> *MC1: So here there are steps, options to go implement that.*
> *R1: So in a way that life cycle planning would only need this first step?*
> *MC1: Well at the minimum that we have this pile of your equipment, tell us where they are at (in their life cycle), and deliver us the information. Then where they (DC) would get something more for themselves is that we would send the conducts of these equipments, the trends, that they are conducting in this way, then there they could already check, if the values are normal or not.*
> *R1: So in a way that in that stage it would bring value to them too.*
> *MC1: Yes. The very first step only benefits us, then the next step would already benefit the both a little. And then maybe the third step that would already benefit CC too would be if there could be suggestions made, that if this would be done differently it (the equipment) would work better, and that could have impact on the quality (of the manufactured product).*

Another recurring trend that the interviewees thought would affect the collaboration positively is transparency in the value chain. DC1 underlined transparency in the value production in order to be able to define the value of the data that the OEMs would sell, while CC1 was more focusing on that there should be clear, continuous communication with the participants of data sharing collaboration to ensure that goals would be reached.

> *DC1: I think that is my only, my best guess, that let us make that value chain transparent, that then there will be less of these types of overaffectations that you ask for a thousand euros for a product that is worth ten euros. That way it will not be solved, and the discourse will get much easier when I can show that this*

guy is paying this amount, this one is paying that amount, then your share of this is ten euros, which I am willing to pay.

CC1: Well in that case if this type of service agreement for example would be made with one supplier, it would require that there would be regular meetings with relevant resources. To meet either face to face or with skype or similar, but they would have to have the communication, and it would proceed then, there would be things that would be done and we would follow characteristics and do a certain type of analysis all the time that... That would be required.

MC1 also highlighted that the collaboration in the value network would specifically be of the continuous kind, as the companies would need to evolve together. They also mentioned this type of collaboration with regular monitoring making it easier for CC to commit to further projects as the business case would be easier to sell as the payback time would be known, which was something that CC1 mentioned earlier in challenges. Another important note is that the main aim here is the savings that CC would make, which was what DC1 expressed worries about that would be the sole goal of the business CC would be ready to commit to.

MC1: But when the data would be open, then it could be done on a continuous basis. To monitor and when an anomaly would be detected, they would be highlighted, so, that would be that type of collaboration, a continuous development of collaboration, some kind of a contract about it that it would be regularly checked and surely the supplier would then want to make suggestions, because they would get sales. And then when there is a good payback, CC will want to buy it, because they save money.

3.4 Empirical Summary

Based on the findings in the empirical research, several interesting things arise.

First of all, digitalisation is seen first and foremost as a possibility with gains further than the interviewees feel that can be grasped at this point. Nevertheless, it has been a long time coming, and all of the companies of the interviewees have been digitising and digitalising their offering and processing for some time now. But since the extent of change through digitalisation is great and unknown, it poses some threats to the organisations, as they have to change their value creation, and companies can fall behind in the trends. The interviewees recognised that moving forwards and harnessing digitalisation in their processes, products and services is a competition they are in against their peers and other, not yet emerged competitors.

The digital transformation that has already been started in the companies has been from what is easy, digitalising already existing processes and gaining in efficiency. However, there are further possibilities for value creation that go beyond mere gains in efficiency, but it requires innovation and is not simple to approach. One of these things that could create value beyond efficiency gains is sharing and analysing Big Data gathered by the companies themselves and those within their value chain. This, however, would require forming closer and continuing cooperation than the current project-like collaboration existing currently between the OEMs and the core companies, CC and MC.

Regarding data sharing and collaboration in the emerging manufacturing industry network, based on the interviews, it has become clear that the interviewees have many views that do not align. The goals that DC1 want to work towards differ greatly from what MC1 and CC1 see as the important goals to work towards to, and even MC1 made statements about goals that show that they come from a different perspective and seek different value from the collaboration than CC1 does.

It also became obvious that the emerging value network or business

ecosystem has in the view of the different interviewees very different members. DC1 sees that one company like DC or ASC could take over for all of the other OEMs, while MC1 and CC1 saw that several players have to be included. It also means that if the network proceeds to form as MC1 and CC1 envisioned it, it would become a business ecosystem due to the fact that there would be competition between the members of the network. On the other hand, in DC1's view, the resulting network would be a value network without competition.

Comparing the situation the emerging value network studied to the phases of formation of an ecosystem as presented by Russo-Spena et al. (2014), it becomes apparent that this value network is still very much at the very beginning of its formation. The members of the network have not yet been selected in a way that would clearly exclude some of the members, there have only been talks about who to include. According to Tsai & Ghoshal (1998), a shared vision would contribute towards the formation of a common identity, but the goals of the network are not defined either, other than very loosely. As such, the common identity of the network has yet to be formed, and as stated by Popp et al. (2014) and Hardy et al. (2005), a common identity is crucial for reaching a network's goals.

Regarding the data marketplace type, during the observation stage of the research, there were mentions of blockchain being a possibility for data sharing, but this was something that the companies saw to be something further away in the future, rather than a type of trading in data that they could already start with. Instead, the type of marketplace they would aim for is based on the observations and the interviews a multilateral collective type of platform as defined by Koutroumpis & Leiponen (2017), which would allow them high confidentiality through strong boundaries to the platform. For what the interviewees were aiming for, a multilateral collective platform for trading data would be the right amount of inclusive and secure, so the lack of DLT such as blockchain would not hinder the emerging data sharing.

Chapter 4

Results

To be able to draw conclusions from this research, the empirical research question are answered, and the answers are discussed in the lights of the theoretical framework that was presented in Chapter 2.

4.1 Answers to the Research Questions

Based on the results of the empirical findings in Chapter 3, the Research Questions presented in Chapter 2 are answered.

> **RQ1: What challenges and tensions do the managers in the emerging network's companies perceive in transforming their supply chain into a value network that would share data?**

During the interviews, several challenges perceived by the companies arose. These challenges are briefly given a description of in Table 4.1, along with the information of which of the interviewees perceived these challenges. The table does not give weight to how many times an interviewee discussed a challenge, but rather focuses on what different challenges are perceived.

Table 4.1: Perceived Challenges

ID	Name	Description	Perceived by
pc1	Understanding and proving the value of data and its analysis	If one company improves its processes or adds value to data via analysis, it needs to be able to prove the value of the work to their customer in order to gain the benefit from it. This is both before taking part in a project, during and after it.	CC1, DC1
pc2	Large transformations are difficult to undertake	Transforming a whole value chain into one that shares data about its processes is a daunting task, and companies do not know how or where to start.	CC1, DC1, MC1
pc3	Transparency for data provenance	Current systems are using legacy technology and lacking in transparency and data protection, that are required for companies to be able to share data, and to perceive the value of it.	CC1, DC1
pc4	Preventing data from ending up in the wrong hands	Data is valuable, and companies do not want their business critical data to end up in the hands of their competitors. Due to the risks, they are reluctant to share data to begin with.	CC1, DC1, MC1
pc5	Division of data ownership, processing and benefits	In a value chain, who owns the data created by its processes may not be clear, and the division of the benefits when data comes from multiple sources is complicated. Some companies have more power than others.	DC1, MC1
pc6	Communicating between different working cultures	Different backgrounds of the people working together makes it difficult to achieve shared understanding between them. Understanding must be achieved within the organisation to be able to transfer it to another organisation.	CC1, DC1
pc7	External demands slow the network down	Lawyers and contracts and external demands complicate making business, and may make it impossible to do business.	CC1, DC1
pc8	Knowledge management from within organisations to between organisations	Organisations lack in knowledge management when it comes to what they are seeking to solve by data sharing and the network transformation, and this makes it difficult to communicate it to the other members of the network.	CC1, DC1
pc9	Harnessing potential beyond the simplest business case	Creating innovative new business is hard, and companies may seek and be satisfied with the simplest business case, which may frustrate others seeking to do something more. Especially with data sharing, there would be a lot more potential.	DC1

These challenges, named by the interviewees, overlap and link to the challenges and tensions found in the literature review. Based on what and how the interviewees discussed these challenges and linked them to others,

links to the theoretical framework presented in Chapter 2 are made. These linkages are listed in Table 4.2. Direct links are emphasised in the table.

Table 4.2: Empirical Challenges Mapped to Theory

	(pc1) Understanding and proving the value of data and its analysis	(pc2) Large transformations are difficult to undertake	(pc3) Transparency for data provenance	(pc4) Preventing data from ending up in the wrong hands	(pc5) Division of data ownership, processing and benefits	(pc6) Communicating between different working cultures	(pc7) External demands slow the network down	(pc8) Knowledge management from within organisations to between organisations	(pc9) Harnessing potential beyond the simplest business case	**Total occurences**
Tensions										
(t1) Efficiency vs. Inclusiveness					x			x		2
(t2) Internal vs. External Legitimacy	x	x	x				x	x	x	6
(t3) Flexibility vs. Stability		x						x		2
(t4) Unity vs. Diversity		x			x	x				3
(t5) Sharing vs. Controlling Data		x	x	x	x		x			5
Network Challenges										
(c1) Consensus and Commitment to Goals	x	x	x					x	x	5
(c2) Working Culture Clashes			x			**X**		x		3
(c3) Loss of Autonomy	x	x		x	x		x			5
(c4) Coordination Fatigue and Costs		x	x				x			3
(c5) Developing Trust				x						1
(c6) Obstacles to Performance and Accountability	x		x		x					3
(c7) Management Complexity								**X**		1
(c8) Power Imbalances					x					1
(c9) Lack of Capacity to Work Collaboratively		x	x			x		x	x	5

Table 4.2 – continued from previous page

	(pc1) Understanding and proving the value of data and its analysis	(pc2) Large transformations are difficult to undertake	(pc3) Transparency for data provenance	(pc4) Preventing data from ending up in the wrong hands	(pc5) Division of data ownership, processing and benefits	(pc6) Communicating between different working cultures	(pc7) External demands slow the network down	(pc8) Knowledge management from within organisations to between organisations	(pc9) Harnessing potential beyond the simplest business case	**Total occurences**
(c10) Sustainability	x									1
(c11) Resistance to Change	x	x						x	x	4
Data Sharing Challenges										
(dc1) Protection of Data				**X**	x		x			3
(dc2) Data Provenance	x		**X**		x		x			4
(dc3) Value of Data	**X**		x	x	x					4

Based on the linkages presented in Table 4.2, the tensions that appear in most challenges that the studied network faces are Internal vs. External Legitimacy (t2) and Sharing vs. Controlling Data (t5). Thus, the network managers feel that the emerging network is experiencing a lot of tension regarding balancing its internal and external legitimacy, and as they seek to share data, they have yet to find a balance where the tension of sharing and controlling data has been sufficiently balanced. Out of the nine challenges identified, all challenges except one were linked to at least one of these two tensions. The only challenge that did not link to either one of these was

Communicating between different working cultures (pc6), which is logical, considering that this problem is not specific to sharing data and thus does not link to (t5), nor is it something that has to do with the internal or external legitimacy of the network.

Furthermore, Communicating between different working cultures (pc6) not being tied to Internal vs. External Legitimacy (t2) or Sharing vs. Controlling Data (t5) fits with what was found in the literature review in Chapter 2. Carlile (2002, 2004) identified communicating between persons coming from different working cultures as a challenge that appears also within an organisation. Thus it is not dependent on having an environment of sharing data or of networks, but rather, it has to do with the unity and diversity within the different members and their working cultures, as presented in Table 4.2.

However, it is notable that all of the tensions found in the theoretical framework could be identified in the challenges that were perceived by the interviewees. As such, it can be said that the interviewed managers of the network indirectly perceived all of these tensions in the emerging network through the challenges that they named.

The network challenges identified from the literature review that appeared most in the challenges perceived by the managers were Consensus and Commitment to Goals (c1), Loss of Autonomy (c3) and Lack of Capacity to Work Collaboratively (c9). Thus a conclusion can be drawn that these challenges were ones they felt were strongly present in the problems they felt that the emerging network faces, and therefore crucial hurdles to overcome for the network to be able to work together. Only slightly less strongly present in the perceived challenges was Resistance to Change (c11), which especially as this is an emerging network, is natural to be strong.

Looking at the perceived challenges themselves and comparing them to the network challenges identified in the literature, two challenges are identified which have direct counterparts in the theoretical and empirical research done for this study. These counterparts are respectively Working Culture

Clashes (c2) and Communicating between different working cultures (pc6), and Management Complexity (c7) and Knowledge management from within organisations to between organisations (pc8). Having a direct link between a challenge perceived and the challenge identified in theory is sign that the challenge is more easily identified by the interviewees in the network, and as such it is likely to be more important for the network as a whole. However, the impact of each challenge itself is not measured in the research, so conclusions can only be drawn that these challenges identified in the theory are strongly perceived to be present in the emerging network by those interviewees that referred to these challenges.

Of the network challenges that were identified in the theoretical framework, the ones that linked the least to the challenges perceived by the interviewees were Developing Trust (c5), Management Complexity (c7), Power Imbalances (c8) and Sustainability (c10). These challenges each linked only to one of the perceived challenges. However, a conclusion can not be drawn that these challenges would be less important or present in the network only based on this, as the amount of links to the perceived challenges can not be argued to rule out the impact of a challenge.

Nevertheless, using what the interviewees said that referred directly to the challenges identified in the theory can give more insight into the importance of them. For example, the interviewees mentioned that having done the pilot project together, they feel that they have developed some trust and understanding between the members of the emerging network, and that having this underlying trust would help them to work together in the future. Thus it can be argued that Developing Trust (c5) might accurately be of less importance in the emerging network, as they have already partly overcome this challenge. However, because Developing Trust (c5) also encompasses maintaining trust, and its challenge was identified to be present in Preventing data from ending up in the wrong hands (pc4), it is still a challenge that is present in the emerging network, although it might not be as strongly perceived as others.

On the other hand, Management Complexity (c7) had very few mentions in the material, and as such no conclusions can be drawn about whether or not its challenge is strongly present in the network or not. However, it was identified to directly link to Knowledge management from within organisations to between organisations (pc8), and as such, it can be argued to be a major part of the challenges perceived by the interviewees, instead of being perhaps a less important challenge in the network.

As for the challenge of Power Imbalances (c8), no strict conclusions can be drawn. Based on the setting, the observations and the interviews, it is clear that there are power imbalances within the network, but in the interviews, the members of the organisations with less power seem to be aware and accepting towards the differences in power. This, however, is based on the feeling of the researcher, and can not be relied on as a result. Nevertheless, the presence of this challenge in the network is still true as part of the identified perceived challenge Division of data ownership, processing and benefits (pc5).

It is interesting that the challenge of Sustainability (c10) has only gotten one link to the challenges perceived by the interviewees. It might be that because of the early stage of the emerging network, sustainability is not perceived as such a challenge, and that it would be more present in a mature network. Still, the challenge was identified to be present in the perceived challenge of Understanding and proving the value of data and its analysis (pc1), and as such, the interviewees are not unaware of this challenge as well, despite the early phase of the network.

There were comparably much fewer data sharing challenges identified from the literature review than network challenges, but all of the data sharing challenges were found to be to a very similar degree present in the perceived challenges when counted in amount of links to the perceived challenges. It is notable that each of the three data sharing challenge had a challenge that directly linked to them or was part of them: for Value of Data (dc3) it was Understanding and proving the value of data and its analysis (pc1), for Data Provenance (dc2) it was Transparency for Data Provenance (pc3) and

for Protection of Data (dc1) Preventing data from ending up in the wrong hands (pc4). The fourth challenge related to data sharing, Division of data ownership, processing and benefits (pc5), could not be directly mapped to any one of these data sharing challenges, but rather, it forms a category of its own, **the challenge of division of data benefits**.

It is important to note that four out of the nine perceived challenges are challenges related to data sharing, and a fifth challenge, Harnessing potential beyond the simplest business case (cs9), is strongly in the context linked to harnessing potential of data, as opposed to the potential of anything else. The perceived challenges that do not directly relate to data sharing are Large transformations are difficult to undertake (pc2), Communicating between different working cultures (pc6), External demands slow the network down (pc7) and Knowledge management from within organisations to between organisations (pc8). Out of these, (pc7) was discussed in the context of sharing data and how the external demands could prevent it, and thus is linked to data sharing challenges in Table 4.2. The others, however, do not have links to the data sharing challenges, nor are they linked to the challenge of sharing data other than that it is the context in which they are perceived.

Based on these, it can be argued that the data sharing challenges found in the literature review are perceived to be strongly present in the emerging network. This is logical, as the purpose of the network is to create value by sharing data.

RQ2: How do the managers in the emerging network's companies feel these challenges could be overcome, and the related tensions could be balanced?

During the interviews, the interviewees mentioned several ways they had already in the preceding research project alleviated the challenges that had risen, and further ways that they felt that going forward would help the members of the emerging network to overcome the challenges it faces. These

ways are briefly given a description of in Table 4.3, along with the information of which of the interviewees mentioned them. The table does not give weight to how many times the interviewee mentioned this way of alleviating a challenge, but rather focuses on what different ways were mentioned.

Table 4.3: Perceived Ways of Overcoming Challenges

ID	Name	Description	Perceived by
pw1	Sharing data continuously	Continuous communication by the members of the network and continuous data sharing would allow for better data creation in the network	CC1, DC1, MC1
pw2	Transparency to the value chain	Understanding the value chain and how value is created in the network gives the companies the possibility to truly assess what value they and others create, and how the benefits should be split fairly	DC1, MC1
pw3	Working towards the same goal	Having a common understanding of what the network is working towards and what the common benefit would be. Agreeing that the network is necessary for solving the issue.	CC1, DC1
pw4	Splitting the starting of the collaboration into smaller tasks or steps	Creating small successes and starting off with something that is easier to achieve makes working towards the long-term goal easier	CC1, DC1

The mentioned ways of overcoming the perceived challenges for the most part link directly to some of the perceived challenges listed in Table 4.1, and some of the challenges identified in the theoretical framework. Transparency to the value chain (pw2) would work towards overcoming the challenges of Understanding and proving the value of data and its analysis (pc1), Transparency for data provenance (pc3) and Division of data ownership, processing and benefits (pc5). Working towards the same goal (pw3) would alleviate Harnessing potential beyond the simplest business case (pc9), as it was discussed as the differences of goals that the members of the emerging network might have. More strongly, however, pw3 is linked to the challenge of Consensus and commitment towards goals (c1), as having the same goal to work towards within the network means that there is consensus about it. Splitting the starting of the collaboration into smaller tasks or steps (pw4), on the other hand, strongly links to the one perceived challenge that is the chal-

lenge of Large transformations being difficult to undertake (pc2), providing a concrete solution to how the challenge can be overcome.

In contrast to these, Sharing data continuously (pw1) does not directly address any one challenge. Rather, it is a more general way for the emerging network to commit towards being a network and work closely together to solve the issue the network is seeking to solve. Instead of addressing a challenge, pw1 ties to the tension of Flexibility vs. Stability (t3), wanting to bring more stability to the network through promise of continuous collaboration. As such, pw1 adds to the tension, pulling towards the side of stability. Sharing data continuously (pw1) also links to Sustainability (c10), but not in the way that it would mitigate the challenge, but rather, the challenge of Sustainability (c10) is what makes Sharing data continuously (pw1) difficult.

4.2 Discussion of the Empirical Results

The objective of this study was to find out what types of challenges and tensions the members in an emerging manufacturing industry network experience while forming their network to share data for value co-creation. This study found that different members of the network experience different challenges, and that these challenges could be divided into ones that were directly related to data sharing, and to ones that were more generally related to forming networks and collaborating within them.

In this particular case of an emerging manufacturing industry network, the tensions that were most obviously present in the challenges the interviewed members of the network experienced were those of Internal vs. External Legitimacy (t2) and Sharing vs. Controlling Data (t5). These suggest that finding the purpose for the network that suits it both internally and externally can be difficult, and that the balance of sharing but still controlling data is not one to be underestimated, as the data that is most valuable to the companies is one that they do not want to lose control of.

In Table 4.2, the challenges identified in the theory are linked to the

challenges identified in the empirical research. These links were made on basis of the description of the challenges in the theory and by identifying traits that link to these challenges in the challenges found in the empirical research. This was done because the challenges that appear in the empirical research are *specific to context* as opposed to the more general challenges that literature discusses.

Linking the challenges in this way shows also interlinkings between the general network challenges found in the literature. For example, Management Complexity (c7) had a direct counterpart in the perceived challenge Knowledge management from within organisations to between organisations (pc8). This perceived challenge, however, linked to other network challenges as well, namely Consensus and Commitment to Goals (c1), Working Culture Clashes (c2), Lack of Capacity to Work Collaboratively (c9) and Resistance to Change (c11). Seeing this further underlines the importance of seeing the challenges perceived by the interviewees as specific to context, and as complex combinations of many challenging aspects of data sharing and working in networks. It also poses further questions about how the challenges affect one another.

Because the perceived data sharing challenges have direct links to their theoretical counterparts in Table 4.2, the accuracy of the hypothesis of linkages between data sharing challenges and network challenges that was presented in Chapter 2 in Table 2.4 on page 55 can be assessed. The links between data sharing challenges and network challenges based on the empirical study are presented in Table 4.4. In the table, links that were hypothesised are marked with "h" and the results based on the empirical study marked with "R".

Additionally, although not part of the original hypothesis, Table 4.2 also includes the relationships of the fourth data sharing challenge, Division of Data Ownership, Processing and Benefits, that was found in the empirical research. Furthermore, links between tensions and data sharing challenges are added to Table 4.4 as additional results, since they can also be identified

using the results documented into Table 4.2.

	(dc1) Protection of Data	(dc2) Data Provenance	(dc3) Value of Data	Division of Data Benefits
Tensions				
(t1) Efficiency vs. Inclusiveness				R
(t2) Internal vs. External Legitimacy		R	R	
(t3) Flexibility vs. Stability				
(t4) Unity vs. Diversity				R
(t5) Sharing vs. Controlling Data	R	R		R
Network Challenges				
(c1) Consensus and Commitment to Goals		R	R	
(c2) Working Culture Clashes		R		
(c3) Loss of Autonomy	h, R	h	R	R
(c4) Coordination Fatigue and Costs	h	h, R		
(c5) Developing Trust	h, R		h	
(c6) Obstacles to Performance and Accountability		R	h, R	R
(c7) Management Complexity				
(c8) Power Imbalances				R
(c9) Lack of Capacity to Work Collaboratively		R		
(c10) Sustainability		h	R	
(c11) Resistance to Change			R	

Table 4.4: Network Challenges and Tensions Mapped to Data Sharing Challenges

From Table 4.4 we can see that the original hypothesis of how data sharing challenges and network challenges link together was not very accurate. Only four out of eight hypothesised links were proven to exist by the results of the

empirical research, and the empirical research found eight additional linkages to the data sharing challenges found in literature that were not present in the hypothesis.

These links found between the general challenges of networks and data sharing challenges are interesting because they show relationships between the different types of challenges, and can be used to further understand how these challenges affect one another. It is worth noting, however, that the links in Table 4.4 do not show whether it is that the general network challenges contribute towards data sharing challenges, or the other way around. Rather, it only proves that the challenges are related to one another, and thus affect one another in various ways.

Some of the links between the challenges are not obvious when put under consideration. For example, how do Data Provenance (dc2) and Consensus and Commitment to Goals (c1) link together? However, the links that do not seem as obvious under first inspection, become clearer when considered in the light of the perceived challenges that linked them together. For example, Data Provenance (dc2) and Consensus and Commitment to Goals (c1) were linked together by the perceived challenge of Transparency for data provenance (pc3). Transparency for data provenance was the challenge of the current systems not being transparent enough for the companies being able to assess the origin and value for data, and see what additional value could be gained from the data, linking c1 and dc2. Thus, the links in Table 4.4 should be considered together with the links in Table 4.2 and Table 4.1, so that the reasons for the relationships between the challenges are more obvious.

Based on Table 4.4, most of the data sharing challenges link to either Loss of Autonomy (c3) or Obstacles to Performance and Accountability (c6). Combining this with the knowledge from Table 4.2, it is notable that the only perceived challenges that link to Obstacles to Performance and Accountability (c6) are data sharing challenges. Thus it can be said that the obstacles to performance and accountability perceived in this case are related to data

sharing. It is also notable that Loss of Autonomy (c3) is a common theme to many data sharing challenges. This can be explained by Loss of Autonomy (c3) being the only general network challenge that was identified to relate to the data sharing tension of Sharing vs. Controlling Data (t5) in the literature review, as showcased in Table 2.6 on page 58.

Otherwise interesting is that all general network challenges except for Management Complexity (c7) had at least one link to a data sharing challenge. This goes to show that the links between the general network challenges and data sharing challenges are many and not to be overlooked, as these challenges seem to be inseparable in the context perceived in this thesis.

Another curious factor is that the data sharing challenges that had most links to general network challenges were Data Provenance (dc2) and Value of Data (dc3), and compared to them, Protection of Data (dc1) and Division of Data Benefits had few links to network challenges. It may be that this is due to Data Provenance (dc2) and Value of Data (dc3) being broader challenges with more aspects affecting them than Protection of Data (dc1) and Division of Data Benefits, but this warrants more research.

In addition to the links between network challenges and data sharing challenges, Table 4.4 shows links between data sharing challenges and tensions. These are novel findings based purely on the empirical research done for this thesis.

Very interesting is that all the other data sharing challenges are related to the tension of Sharing vs. Controlling Data (t5), but this research did not find a link between the challenge of Value of Data (dc3) and Sharing vs. Controlling Data (t5). This may be because the difficulty of defining the value of data and the willingness to share data and keep control over them are not so obviously linked to one another as the other data sharing challenges. It also may be that the difficulty of the assessment of the value of data simply does not have an effect on the tension of Sharing vs. Controlling Data (t5), but that is a conclusion that can not be drawn only based on this study, but rather, should be considered in future research.

The other tension that got several links to data sharing challenges in Table 4.4 was Internal vs. External Legitimacy (t2). Based on the findings of this thesis, Data Provenance (dc2) and Value of Data (dc3) affect how the network can balance its Internal vs. External Legitimacy (t2). Based on the many links Internal vs. External Legitimacy (t5) had to the perceived challenges, as shown in Table 4.2, and that it has clear links to data sharing tensions as well, the importance of the tension of Internal vs. External Legitimacy in the context of data sharing in an emerging manufacturing industry network is further underlined.

Interesting is also that the new data sharing challenge found in this thesis, the challenge of Division of Data Benefits, was found to have most links to the network tensions. Thus, based on the results of the empirical research done in this study, Division of Data Benefits has the broadest effect on network tensions out of the data sharing challenges found.

As Division of Data Benefits was a data sharing challenge found in the empirical research, but not the literature review, considering it against the literature reviewed in Chapter 2 is appealing. Koutroumpis & Leiponen (2017) regard data market dynamics and that the buyers and sellers must perceive that there is benefit in the trade for them to partake in it. Thomas & Leiponen (2016) passingly mention data ownership and the division of the benefits of Big Data analysis. However, they consider this in the context of companies and their end customers, where data are about these customers and the usage of these products. Porter & Heppelmann (2014) consider data ownership as well, but again in the context of an ecosystem analysing data created by and of their end customers.

The context of companies collecting data of end customers is different from the manufacturing industry context considered in this study, as data in the context of this thesis are collected from processes rather than persons and their usage of products. As such, there are no similar privacy concerns in the emerging manufacturing industry business network case, but rather there are concerns about the competitive advantage in processes leaking to

other, competing companies. However, based on the results of this study, the concerns about data ownership are important also in the case where data is collected from processes and shared between organisations.

In addition to challenges and tensions, this study found in its empirical research ways that the members of an emerging manufacturing industry network felt that the challenges they were experiencing could be mitigated and tensions could be balanced. Some of these linked directly to a challenge or challenges identified, but Sharing data continuously (pw1) linked instead directly to a tension, the tension of Flexibility vs. Stability (t3). Those challenges that had a direct link to a way of overcoming them are thus ones that the interviewees perceived there to be clear solutions to. The other challenges either had no obvious ways of overcoming them in the eyes of the interviewees, or they did not mention any.

It can be argued that all three interviewees perceived the sustainability of the network as important. This argument is made because the one way of mitigating challenges that all three interviewees mentioned was Sharing data continuously (pw1), which requires for the network to be sustainable towards its purpose. It makes sense, as logically data sharing is not something that would be sensible when done only during a short time span, but rather, as an on-going, long-term collaboration. Requiring continuous data sharing again reaffirms that a network or an ecosystem is the right way of solving the issue of Big Data analysis in the context of manufacturing industry, as one of the important reasons of choosing a network listed by Popp et al. (2014) was requiring long-term collaboration.

Chapter 5

Conclusions

In this chapter, the conclusions of this thesis are drawn by answering the research problem. In addition to this, both practical and theoretical implications from the results of this thesis are inferred, and suggestions for future research are made. Finally, the research itself is evaluated using the criteria proposed by Lincoln & Guba (1985).

5.1 Answer to the Research Problem

Based on the research done and the answers to the research questions, the research problem posed for this thesis in Chapter 1 can be answered.

> **What are the challenges and tensions in emerging manufacturing industry networks that seek to share data?**

This study found based on literature eleven challenges and four tensions related to working in networks, a tension related to data sharing, and three challenges related to data sharing. These are listed in the Table 5.1. An additional data sharing challenge, Division of Data Ownership, Processing and Benefits, was found in the empirical research, and is also listed in the Table.

Table 5.1: Summary of Challenges and Tensions Found

Type	Name
General Network Challenges	Consensus and Commitment to Goals (c1)
	Working Culture Clashes (c2)
	Loss of Autonomy (c3)
	Coordination Fatigue and Costs (c4)
	Developing Trust (c5)
	Obstacles to Performance and Accountability (c6)
	Management Complexity (c7)
	Power Imbalances (c8)
	Lack of Capacity to Work Collaboratively (c9)
	Sustainability (c10)
	Resistance to Change (c11)
General Network Tensions	Efficiency vs. Inclusiveness in the Network (t1)
	Internal vs. External Legitimacy of the Network (t2)
	Flexibility vs. Stability of the Network (t3)
	Unity vs. Diversity in Network (t4)
Data Sharing Tension	Sharing Data vs. Controlling Data (t5)
Data Sharing Challenges	Protection of Data (dc1)
	Data Provenance (dc2)
	Value of Data (dc3)
	Division of Data Ownership, Processing and Benefits

All of the challenges and tensions identified in the literature were also found in the empirical study, thus proving that they do appear at least in this examined case of an emerging manufacturing industry network that seeks to share data. Therefore they are relevant for this type of networked data sharing in the manufacturing industry.

It was also proven that these different challenges and tensions link together. From literature, links between the tensions of networks and the general network challenges were identified into Table 2.6 on page 58. Links between general network challenges and data sharing challenges were hypoth-

esised in Table 2.4 on page 55 and partly proven with additional links found in Table 4.4 on page 101. Additionally, Table 4.4 shows that based on the empirical study of this thesis, data sharing challenges also link to network tensions.

Based on the links between the tensions and challenges found in the theoretical and empirical research, this study concludes that the most prominent tensions in an emerging data sharing manufacturing industry network are Internal vs. External Legitimacy (t2) and Sharing Data vs. Controlling Data (t5). The most prominent network challenges were Consensus and Commitment to Goals (c1), Loss of Autonomy (c3) and Lack of Capacity to Work Collaboratively (c9). There were no clear differences found in the empirical or theoretical research between the importance of the data sharing challenges. Additionally, this thesis concludes that the general network challenges that were most heavily linked to data sharing within an emerging data sharing network were Loss of Autonomy (c3) and Obstacles to Performance and Accountability (c6).

The results of this thesis show, that an emerging manufacturing industry network seeking to share data experiences tensions and challenges related both generally to working in networks, as well as to sharing data. Thus, an emerging manufacturing industry network seeking to share data needs to take into account both specific challenges that sharing data brings as well as challenges of working in networks, and neither aspect should be underestimated. This further verifies that only developing a technical solution for the problem of sharing data is not sufficient to make data sharing in a network work.

5.2 Implications

The theoretical and empirical research made has implications for both practitioners that are facing or considering facing similar situations as the one described in the case, and researchers and others interested in the theory of

data sharing in emerging networks, and broader related theoretical subjects.

5.2.1 Practical Implications

As this study was a single case study into an emerging manufacturing industry network seeking to create value through the sharing of data, companies and their managers in similar organisations seeking similar value through digitalisation can benefit from the learnings of this thesis.

The results of this study suggests that data sharing in an emerging manufacturing industry network is a complicated task with many aspects to take into account. According to the literature review done for this thesis, there are tensions in networks that need to be found balance in, and that define the nature and identity of the network or ecosystem. As such, managers should be aware of these tensions and how they might affect them as they seek to collaborate to benefit from data sharing in a network or an ecosystem.

On top of tensions to balance, the emerging network or ecosystem will face challenges they need to overcome. These challenges may be related to forming networks and collaborating in them, or data sharing. It is important to note that data sharing brings additional challenges to networked collaboration, as opposed to collaborating over a physical product or e.g. a maintenance service. As such, practitioners gain from understanding the difficulties creating value through data sharing has as opposed to all other value co-creation. However, also the challenges of networked collaboration need to be taken into account, and not overlooked while the network focuses on sharing data.

This thesis also shows that challenges and tensions affect one another. Practitioners should take the links between challenges and tensions into account while seeking to respectively overcome and balance them.

Furthermore, this thesis introduces ways of working that can make reaching the goal of creating value through data sharing in a network easier. Based on the challenges identified and the ways of mitigating them found in this research, and the comments and experiences of the interviewees, the follow-

ing guidelines for practitioners seeking to create value through data sharing in an emerging network are suggested:

1. **Figure out a business case to begin with.** The potential of digitalisation and Big Data analytics is unquestioned, but figuring out a viable business case that creates value for the network is difficult. Having a business case, however, gives a clear goal to work towards, and external legitimacy is more easily gained when there is concrete value to be gained in sight.

2. **Start with the smallest possible useful application of data.** Getting something to work gives both motivation and builds trust for the network, and ensures that the systems are compatible and able to share data. After the first step is successful, more can be built on top of it.

3. **Make value creation transparent.** Due to the nature of data as information goods, evaluating its value is difficult, and thus sharing it becomes difficult as participants fear they get cheated out of value. Making the value chain clear and transparent allows each participant to assess the value they create accurately.

4. **Get the right people and companies involved.** Tackling something new like data sharing requires new competence, so choosing partners into the network that have this is crucial. Communicating what is needed requires good knowledge management both within and between organisations, and the difficulty of forming a shared understanding should not be underestimated.

Recognising the challenges and the changes that working with data brings to a network's collaboration is important for the network, as being prepared for a challenge or risk makes dealing with it when it happens easier. As such, the greatest giveaway of this thesis for practitioners is giving an understand-

ing about what is difficult in an emerging data sharing network and to give ideas about how to mitigate these difficulties.

5.2.2 Theoretical Implications and Future Research

For theoretical implications, the framework constructed for the tensions and challenges that appear in emerging networks or ecosystems seeking value through data sharing can be used to develop further understanding about challenges of networks and data sharing. Especially business and management related challenges of data sharing in networks is a topic that has not gotten much attention in literature yet, and this thesis both summarises existing knowledge and provides new knowledge from research made into this topic.

The results of this study suggest that there are certain tensions in networks that need to be balanced, and challenges that need to be overcome. The linking of tensions and challenges as done in this thesis is unique, and can be used to further understand how challenges a network experiences can be tied to the driving forces of networks that form the tensions as described by Popp et al. (2014) and Saz-Carranza & Ospina (2011). In addition to the tensions that they have discussed, this research found that applying the research by Koutroumpis & Leiponen (2017), there is also a tension of sharing vs. controlling data that applies to a network that seeks to share data, and may also be applicable to a network that is already sharing some data. This fundamental tension of data sharing networks is a clear addition to previous research, and its existence was proven in the empirical research done for this study.

The four main challenges of data sharing found in this study suggest that data sharing brings its own challenges into a network, and that these challenges relate specifically to the nature of data as types of information and experience goods. For theory, this implies that analysing and trading with Big Data requires networks to face additional challenges to the ones that are recognised as the challenges that emerging networks might face. This thesis

also shows how the data sharing challenges found link to general challenges and tensions of a network, and what sort of general challenges an emerging network or ecosystem seeking to share data might experience strongly.

This study also gives some insight into that some challenges and tensions may be more prevalent in the early stages of an emerging network or ecosystem as opposed to other times in the lifecycle of a network or ecosystem. It also shows that members in different positions in the network experience different challenges, although these also overlap. This provides interesting starting points for future research, where these aspects may be further studied.

Starting from the findings presented in this study, future research may seek to find how strongly different tensions and challenges are perceived in different stages of a data sharing network or ecosystem, and how this perception varies depending on the position of the organisation the observed persons are from. Fruitful would be following a network or ecosystem throughout its formation, and seeing how it experiences challenges and how they are overcome.

Related to the theoretical framework created through the theoretical and empirical study in this thesis, future research could seek to verify and further study the links between network tensions and challenges related to networks and challenges related to data sharing.

Other interesting areas for future research would be the comparison of emerging networks that seek value through data sharing, both in the same industry and across industries. Interesting would also be what sort of challenges and tensions an emerging network that has never worked together before would experience in the beginning of their transformation, and through it how much having worked together with the companies would affect the collaboration in the beginning.

It would also be interesting to follow if and how the ecosystem created would globalise its value creation through data. Additional difficulties are likely to appear in this situation, but should the companies seeking value

through data sharing already be operating on a global scale, it is likely that expanding the ecosystem onto a global scale could be attractive.

5.3 Evaluation

This study has been conducted using a literature review and combining and comparing the findings iteratively through abductive logic with the results of an empirical study. As this study was conducted as a qualitative case study (Creswell 2009, Yin 2009), the trustworthiness of this study is evaluated through its credibility, transferability, dependability and confirmability, the four criteria for evaluating qualitative study proposed by Lincoln & Guba (1985).

After evaluating the trustworthiness of this study, its limitations are discussed.

5.3.1 Credibility, Transferability, Dependability and Confirmability

As stated before, in qualitative research, the analysis of data is based on the interpretations of the researcher, and as such, the influence of the researcher's prior knowledge and understanding about the subject on the research is a fundamental aspect of qualitative research (Creswell 2009). Due to this influence, it is necessary that the trustworthiness of the research is thoroughly evaluated. Lincoln & Guba (1985) proposed their four criteria for qualitative research, credibility, transferability, dependability and confirmability, for this exact purpose.

Credibility of the research describes the trustfulness and persuasiveness of the causalities and relationships that have been inferred (Guba & Lincoln 1989). Credibility of the study is justified by the credibility of interpretations, external validation of the inquiry, continuous revision of hypotheses, and referential adequacy (Lincoln & Guba 1985).

This study has been conducted using abductive logic, in which literature and empirical data are constantly compared, combined and refined over the course of the study (Dubois & Gadde 2002, Kovács & Spens 2005). Thus, choosing abductive logic gives this thesis advantage through additional credibility, as its hypotheses have been continuously revised and adapted over the course of the research to reach the best theoretical explanation for the studied real-life phenomenon (Kovács & Spens 2005).

According to Hirsjärvi & Hurme (2000), using both observations and interviews in research gives a broader perspective into the researched subject, increasing the reliability of the research. Both observations and interviews were recorded and analysed in this research, giving a broad look into the subject and a deeper understanding about the situation.

Regarding the credibility of interpretations and referential adequacy, all of the recorded audio and video material used in the research has been archived in its original form, so external parties that may want to test the interpretation against the data have the possibility to do so through the preserved material (Lincoln & Guba 1985). The transcribed versions of the interviews that include the labels and links made by the researcher are encoded into the analysis software Atlas.ti, and may also be used to review the credibility of the observations and inferences made.

For one of the interviews, the researcher was not the only person present, but rather, the supervisor of this thesis took part in the interview as well. Thus some additional credibility through the external validation of what conspired in the first interview was gained.

Transferability describes the extent to which the findings of the study can be generalised, that is, applied in other contexts and to other research subjects (Lincoln & Guba 1985). In qualitative research, such as done in this thesis, the transferability of the findings of the study can only be determined by an external person, not the researcher or researchers themselves (Eisenhardt 1989, Guba & Lincoln 1989). To provide others the possibility to assess the transferability of this study, extensive descriptions and documentation

about the context, theory, methods, analysis, decisions and results have been given (Lincoln & Guba 1985). The limitations of the generalisability are also discussed in the next section.

Dependability addresses the consistency of the study with the aim of providing results independent from the researcher's identity (Guba & Lincoln 1989). Due to the qualitative nature of the study and the abductive inference logic used leaning heavily on and accepting the role of the researcher as the interpreter of the data (Creswell 2009, Ketokivi & Mantere 2010), the results of the study are also to be considered taking into account the role of the researcher. To provide insight into the interpretations made, extensive documentation of the analysis of the data has been provided.

Levina (2005) state that when using a boundary object, it is important that it gets challenged, or there will be no proper innovation and collaboration. Thus, a challenge with using a boundary object made by the researcher is that it sets the conversation into a direction determined by the researcher. However, the boundary object, which companies were included in it, and in what composition were questioned by all of the interviewees, so there was true collaboration and information gotten from the interviewees, rather than the interviewer imposing thoughts without the possibility of them being challenged. Thus, using the self-made boundary object has not compromised the dependability of this study. Furthermore, the boundary object template is presented in the study. The end result of these boundary objects are not included, as they include the names of the companies involved in the network, and sensitive details about their future plans and value creation. They are, however, archived for later review.

It is also important to note that the interviews were conducted in Finnish, and the excerpts that are found in this thesis are translated by the researcher, and thus should be considered to have been influenced by the bias of the researcher as well. However, the original recordings and Finnish transcriptions of the interviews are available for translation and interpretation by other sources.

Confirmability, the final criterion, is concerned about the extent to which the characteristics of the data, as posited by the researcher, can be confirmed and tracked back to the data by others who review the results of the research (Lincoln & Guba 1985). Through confirmability, the neutrality of the study regarding it being free of bias, values and prejudice, can be determined (Guba & Lincoln 1989). The availability of the original data for any person who may seek to evaluate the research gives this person the possibility to evaluate both its dependability and confirmability (Guba & Lincoln 1989). Additionally, quotes from the data are presented in a translated form in Chapter 3 to further support the empirical findings of this study.

5.3.2 Limitations

The most important limitation of this study is that as it has been conducted as a qualitative study, its results can not be generalised to other samples (Yin 2009). The focus of this study was on emerging manufacturing industry networks seeking to create value through data sharing. As such, its results can not be expected to apply similarly to incumbent networks, networks in other industries, or networks that do not seek value through data sharing. Instead, its results can be used as analytical generalisations to develop further the theoretical understanding of the phenomena involved (Yin 2009).

The other major limitation of this study is that it had only three observation workshops, three interviewees and interviews, and only one network was under inspection. Thus, the sample studied is small in size, although it was examined in depth. However, through the small sample size, the results of this study are heavily tied to the single case and its context. Thus, the importance of each interview and the conduct in each interview rises, and any flaw is more significant in the sample. Furthermore, the data is heavily affected by what topics the interviewees chose to bring up and discuss about in depth when asked about the network. Because of this, the true importance of each challenge mentioned is difficult to assess, as a challenge that an interviewee happened to talk about more could get undue emphasis in the

data.

Having collected data from the separate observations mitigates the effects of the small amount of interviews some. However, the interviewees were not present in all of the observations, but rather, there were other members from their organisations and others providing their views on the topic of the network and data sharing. Due to the lack of structure of the events the observations were done in, there was little of use in the observation data collected for this study.

Bibliography

Adner, R. (2006), 'Match your innovation strategy to your innovation ecosystem', *Harvard business review* **84**(4), 98.

Adner, R. & Kapoor, R. (2010), 'Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations', *Strategic management journal* **31**(3), 306–333.

Akkermans, H., Bogerd, P. & Van Doremalen, J. (2004), 'Travail, transparency and trust: A case study of computer-supported collaborative supply chain planning in high-tech electronics', *European Journal of Operational Research* **153**(2), 445–456.

Alasoini, T. (2015), 'Digitalisaatio muuttaa työtä – millaista työelämää uudistavaa innovaatiopolitiikkaa tarvitaan', *Työpoliittinen aikakauskirja* **2**(2015), 26–37.

Albinsson, L., Lind, M. & Forsgren, O. (2007), 'Co-design: an approach to border crossing, network innovation', *Expanding the knowledge economy: issues, applications, case studies* **4**(Part 2), 977–983.

Atzori, L., Iera, A. & Morabito, G. (2010), 'The internet of things: A survey', *Computer networks* **54**(15), 2787–2805.

Batini, C., Cappiello, C., Francalanci, C. & Maurino, A. (2009), 'Methodologies for data quality assessment and improvement', *ACM Comput. Surv.* **41**, 16:1–16:52.

Batini, C. & Scannapieco, M. (2006), 'Data quality concepts, methodologies and techniques'.

Bechky, B. A. (2003), 'Sharing meaning across occupational communities: The transformation of understanding on a production floor', *Organization science* **14**(3), 312–330.

Bengtsson, M. & Kock, S. (2000), '"coopetition" in business networks - to cooperate and compete simultaneously', *Industrial marketing management* **29**(5), 411–426.

Brem, A. & Voigt, K.-I. (2009), 'Integration of market pull and technology push in the corporate front end and innovation management - insights from the german software industry', *Technovation* **29**(5), 351–367.

Carlile, P. R. (2002), 'A pragmatic view of knowledge and boundaries: Boundary objects in new product development', *Organization science* **13**(4), 442–455.

Carlile, P. R. (2004), 'Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries', *Organization science* **15**(5), 555–568.

Catalini, C. & Gans, J. S. (2016), Some simple economics of the blockchain, Technical report, National Bureau of Economic Research.

Chebli, O., Goodridge, P. & Haskel, J. (2015), 'Measuring activity in big data: New estimates of big data employment in the uk market sector.', *Imperial College Business School Discussion Paper* p. 28.

Coch, L. & French Jr, J. R. (1948), 'Overcoming resistance to change', *Human relations* **1**(4), 512–532.

Cohen, D. (1998), 'Toward a knowledge context: Report on the first annual uc berkeley forum on knowledge and the firm', *California management review* **40**(3), 22–39.

Creswell, J. W. (2009), *Research design: Qualitative, quantitative, and mixed methods approaches*, Sage publications.

David, P. A. (1990), 'The dynamo and the computer: an historical perspective on the modern productivity paradox', *The American Economic Review* **80**(2), 355–361.

De Geus, A. (1988), *Planning as learning*, Harvard Business Review March/April.

DiMaggio, P. & Powell, W. W. (1983), 'The iron cage revisited: Collective rationality and institutional isomorphism in organizational fields', *American sociological review* **48**(2), 147–160.

Dubois, A. & Gadde, L.-E. (2002), 'Systematic combining: an abductive approach to case research', *Journal of business research* **55**(7), 553–560.

Duch-Brown, N., Martens, B. & Mueller-Langer, F. (2017), 'The economics of ownership, access and trade in digital data', *JRC Digital Economy Working Paper* **01**.

Eisenhardt, K. M. (1989), 'Building theories from case study research', *Academy of management review* **14**(4), 532–550.

Evans, P. C. & Annunziata, M. (2012), 'Industrial internet', *Pushing the Boundaries of Minds and Machines* **26**.

Fisher, C. W. & Kingma, B. R. (2001), 'Criticality of data quality as exemplified in two disasters', *Information & Management* **39**(2), 109–116.

Gans, J. S. & Stern, S. (2010), 'Is there a market for ideas?', *Industrial and Corporate Change* **19**(3), 805–837.

Gantz, J. & Reinsel, D. (2012), 'The digital universe in 2020: Big data, bigger digital shadows, and biggest growth in the far east', *IDC iView: IDC Analyze the future* **2007**(2012), 1–16.

Granovetter, M. (1983), 'The strength of weak ties: A network theory revisited', *Sociological theory* pp. 201–233.

Granovetter, M. S. (1977), The strength of weak ties, *in* 'Social networks', Elsevier, pp. 347–367.

Guba, E. G. & Lincoln, Y. S. (1989), *Fourth generation evaluation*, Sage.

Gubbi, J., Buyya, R., Marusic, S. & Palaniswami, M. (2013), 'Internet of things (iot): A vision, architectural elements, and future directions', *Future generation computer systems* **29**(7), 1645–1660.

Gulati, R., Puranam, P. & Tushman, M. (2012), 'Meta-organization design: Rethinking design in interorganizational and community contexts', *Strategic Management Journal* **33**(6), 571–586.

Hardy, C., Lawrence, T. B. & Grant, D. (2005), 'Discourse and collaboration: The role of conversations and collective identity', *Academy of management review* **30**(1), 58–77.

Hazen, B. T., Boone, C. A., Ezell, J. D. & Jones-Farmer, L. A. (2014), 'Data quality for data science, predictive analytics, and big data in supply chain management: An introduction to the problem and suggestions for research and applications', *International Journal of Production Economics* **154**, 72–80.

Hirsjärvi, S. & Hurme, H. (2000), *Tutkimushaastattelu: Teemahaastattelun teoria ja käytäntö*, Yliopistopaino.

Iansiti, M. & Levien, R. (2004), *The keystone advantage: what the new dynamics of business ecosystems mean for strategy, innovation, and sustainability*, Harvard Business Press.

Inkpen, A. C. & Tsang, E. W. (2005), 'Social capital, networks, and knowledge transfer', *Academy of management review* **30**(1), 146–165.

Kagermann, H. (2015), *Change Through Digitization – Value Creation in the Age of Industry 4.0*, Springer Fachmedien Wiesbaden, Wiesbaden, pp. 23–45.

Keast, R., Mandell, M. P., Brown, K. & Woolcock, G. (2004), 'Network structures: Working differently and changing expectations', *Public administration review* **64**(3), 363–371.

Ketokivi, M. & Mantere, S. (2010), 'Two strategies for inductive reasoning in organizational research', *Academy of Management Review* **35**(2), 315–333.

Khatri, V. & Brown, C. V. (2010), 'Designing data governance', *Communications of the ACM* **53**(1), 148–152.

Kilker, J. (1999), 'Conflict on collaborative design teams: understanding the role of social identities', *IEEE Technology and Society Magazine* **18**(3), 12–21.

Koutroumpis, P. & Leiponen, A. (2017), Markets for data. Unpublished Manuscript.

Kovács, G. & Spens, K. M. (2005), 'Abductive reasoning in logistics research', *International Journal of Physical Distribution & Logistics Management* **35**(2), 132–144.

Kurzweil, R. (2004), The law of accelerating returns, *in* 'Alan Turing: Life and Legacy of a Great Thinker', Springer, pp. 381–416.

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T. & Hoffmann, M. (2014), 'Industry 4.0', *Business & Information Systems Engineering* **6**(4), 239–242.

Lavikka, R., Hirvensalo, A., Smeds, R. & Jaatinen, M. (2017), Transforming a supply chain towards a digital business ecosystem, *in* 'IFIP International Conference on Advances in Production Management Systems', Springer, pp. 295–301.

Leonard-Barton, D. (1995), 'Wellsprings of knowledge: Building and sustaining the sources of innovation', *Harvard Business School Press, Boston, MA* .

Levina, N. (2005), 'Collaborating on multiparty information systems development projects: A collective reflection-in-action view', *Information Systems Research* **16**(2), 109–130.

Lincoln, Y. S. & Guba, E. G. (1985), *Naturalistic inquiry*, Vol. 75, Sage.

Loebbecke, C. & Picot, A. (2015), 'Reflections on societal and business model transformation arising from digitization and big data analytics: A research agenda', *The Journal of Strategic Information Systems* **24**(3), 149–157.

Loebbecke, C., van Fenema, P. C. & Powell, P. (2016), 'Managing inter-organizational knowledge sharing', *The Journal of Strategic Information Systems* **25**(1), 4–14.

Lucke, D., Constantinescu, C. & Westkämper, E. (2008), Smart factory-a step towards the next generation of manufacturing, *in* 'Manufacturing systems and technologies for the new frontier', Springer, pp. 115–118.

Lusch, R. F., Vargo, S. L. & Tanniru, M. (2010), 'Service, value networks and learning', *Journal of the academy of marketing science* **38**(1), 19–31.

Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P. & Marrs, A. (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy*, Vol. 180, McKinsey Global Institute San Francisco, CA.

Merton, R. K., Fiske, M. & Kendall, P. A. (1956), *The focused interview; a manual of problems and procedures.*, Free Press.

Milward, H. B. & Provan, K. G. (2006), *A manager's guide to choosing and using collaborative networks*, Vol. 8, IBM Center for the Business of Government Washington, DC.

Moore, J. F. (1996), *The death of competition: leadership and strategy in the age of business ecosystems*, HarperBusiness New York.

Moore, J. F. (1998), 'The rise of a new corporate form', *Washington Quarterly* **21**(1), 167–181.

Negroponte, N. (1995), 'Being digital', *Vintage Books, New York* .

Nonaka, I. (1994), 'A dynamic theory of organizational knowledge creation', *Organization Science* **5**(1), 14–37.

Nonaka, I. & Takeuchi, H. (1995), *The knowledge-creating company: How Japanese companies create the dynamics of innovation*, Oxford university press.

Oliva, R. & Kallenberg, R. (2003), 'Managing the transition from products to services', *International journal of service industry management* **14**(2), 160–172.

Ostrom, E. (1990), 'Governing the commons: the evolution of institutions for collective action'.

Paavola, S. & Hakkarainen, K. (2005), 'The knowledge creation metaphor – an emergent epistemological approach to learning', *Science & Education* **14**(6), 535–557.

Page, S. (2004), 'Measuring accountability for results in interagency collaboratives', *Public Administration Review* **64**(5), 591–606.

Paquin, R. L. & Howard-Grenville, J. (2013), 'Blind dates and arranged marriages: Longitudinal processes of network orchestration', *Organization Studies* **34**(11), 1623–1653.

Peltoniemi, M. (2004), Cluster, value network and business ecosystem: Knowledge and innovation approach, *in* 'Organisations, Innovation and Complexity: New Perspectives on the Knowledge Economy', pp. 9–10.

Peltoniemi, M. & Vuori, E. (2004), Business ecosystem as the new approach to complex adaptive business environments, *in* 'Proceedings of eBusiness research forum', Vol. 2, Citeseer, pp. 267–281.

Peppard, J. & Rylander, A. (2006), 'From value chain to value network:: Insights for mobile operators', *European Management Journal* **24**(2-3), 128–141.

Popp, J., MacKean, G. L., Casebeer, A., Milward, H. B. & Lindstrom, R. R. (2014), 'Inter-organizational networks: A critical review of the literature to inform practice', *IBM Center for The Business of Government: Collaborating Across Boundaries Series* .

Porter, M. E. & Heppelmann, J. E. (2015), 'How smart, connected products are transforming companies', *Harvard Business Review* **93**(10), 96–114.

Porter, M. & Heppelmann, J. (2014), 'How smart, connected products are transforming competition', *Harvard Business Review* **92**(11), 64–88.

Provan, K. G., Beagles, J. E. & Leischow, S. J. (2011), 'Network formation, governance, and evolution in public health: The north american quitline consortium case', *Health care management review* **36**(4), 315.

Provan, K. G. & Kenis, P. (2008), 'Modes of network governance: Structure, management, and effectiveness', *Journal of public administration research and theory* **18**(2), 229–252.

Provan, K. G. & Lemaire, R. H. (2012), 'Core concepts and key ideas for understanding public sector organizational networks: Using research to inform scholarship and practice', *Public Administration Review* **72**(5), 638–648.

Raynor, M. E. & Cotteleer, M. J. (2015), 'The more things change: Value creation, value capture, and the internet of things', *Deloitte Review* **17**, 51–65.

Redman, T. C. (2016), 'Bad data costs the u.s. $3 trillion per year', *Harvard Business Review* (22).

Ritala, P., Golnam, A. & Wegmann, A. (2014), 'Coopetition-based business models: The case of amazon. com', *Industrial Marketing Management* **43**(2), 236–249.

Roth, A. E. (2002), 'The economist as engineer: Game theory, experimentation, and computation as tools for design economics', *Econometrica* **70**(4), 1341–1378.

Roth, A. E. (2008), 'What have we learned from market design?', *The Economic Journal* **118**(527), 285–310.

Russo-Spena, T. & Mele, C. (2012), '"five co-s" in innovating: a practice-based view', *Journal of Service Management* **23**(4), 527–553.

Russo-Spena, T., Tregua, M. & Bifulco, F. (2014), 'Collaborative practices in innovation ecosystems', *Adv. Hum. Side Serv. Eng* **1**, 270.

Russom, P. (2011), 'Big data analytics', *TDWI best practices report, fourth quarter* **19**, 40.

Sarajärvi, A. & Tuomi, J. (2009), 'Laadullinen tutkimus ja sisällönanalyysi', *Helsinki: Tammi* **6**.

Saz-Carranza, A. & Ospina, S. M. (2011), 'The behavioral dimension of governing interorganizational goal-directed networks? managing the unity-diversity tension', *Journal of Public Administration Research and Theory* **21**(2), 327–365.

Shapiro, C. & Varian, H. R. (1998), *Information rules: a strategic guide to the network economy*, Harvard Business Press.

Smeds, R., Lavikka, R., Jaatinen, M. & Hirvensalo, A. (2015), Interventions for the co-creation of inter-organizational business process change, *in*

'IFIP International Conference on Advances in Production Management Systems', Springer, pp. 11–18.

Star, S. L. (1989), The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving, *in* 'Distributed artificial intelligence', Elsevier, pp. 37–54.

Thomas, L. D. & Autio, E. (2014), The fifth facet: The ecosystem as an organizational field, *in* 'Academy of Management Proceedings', Vol. 2014, Academy of Management, p. 10306.

Thomas, L. D. & Leiponen, A. (2016), 'Big data commercialization', *IEEE Engineering Management Review* **44**(2), 74–90.

Truong, H.-L., Comerio, M., De Paoli, F., Gangadharan, G. & Dustdar, S. (2012), 'Data contracts for cloud-based data marketplaces', *International Journal of Computational Science and Engineering* **7**(4), 280–295.

Tsai, W. & Ghoshal, S. (1998), 'Social capital and value creation: The role of intrafirm networks', *Academy of management Journal* **41**(4), 464–476.

Turner, V., Gantz, J. F., Reinsel, D. & Minton, S. (2014), 'The digital universe of opportunities: Rich data and the increasing value of the internet of things', *IDC Analyze the Future* .

Vargo, S. L., Maglio, P. P. & Akaka, M. A. (2008), 'On value and value co-creation: A service systems and service logic perspective', *European management journal* **26**(3), 145–152.

Walport, M. (2016), 'Distributed ledger technology: Beyond blockchain', *UK Government Office for Science* .

Wang, R. Y. & Strong, D. M. (1996), 'Beyond accuracy: What data quality means to data consumers', *Journal of management information systems* **12**(4), 5–33.

Weill, P. & Woerner, S. L. (2015), 'Thriving in an increasingly digital ecosystem', *MIT Sloan Management Review* **56**(4), 27.

Yin, R. K. (2009), *Case Study Research, Design & Methods 4th ed.*

Appendix A

Table 2: Labels Used in Data Analysis

Name	Description	Origin	Count
asymmetry of knowledge	Asymmetry of knowledge exists or may exist between members of the network	emerged	5
big data: difficulties	The perceived difficulties that collecting and analysing Big Data inherently has	initial	15
big data: possibilities	The perceived possibilities that collecting and analysing Big Data inherently has	initial	0
bo: foster	Aspects that would foster value creation within the network presented in the boundary object	initial	13
bo: hinder	Aspects that would hinder value creation within the network presented in the boudary object	initial	25
bo: participants	Organisations that should be part of the network presented in the boundary object	initial	12
bo: requirements	Requirements of value creation within the network presented in the boundary object	initial	11
bo: roles	Roles of different members of the network presented in the boundary object	initial	31
bo: value	Potential value the members of the network presented in the boundary object could create together	initial	42
c1: goal consensus & commitment	Achieving commitment and consensus on the goals that the network should pursue	from theory	15
c2: working culture clashes	Clashes that happen when different working cultures do not fit together	from theory	6
c3: loss of autonomy	The fear of an independent company losing its autonomy through being tied to a network	from theory	8
c4: coordination fatigue	The costs and fatigue that working in a network incurs	from theory	9
c5: trust	Trust in a network enables collaboration, but is challenging to develop	from theory	2
c6: accountability	Roles and ensuring accountability in a network	from theory	15
c7: management complexity	Managing change within and between organisations	from theory	2
c8: power imbalances	Members of the network have differing amounts of power over one another	from theory	3

Name	Description	Origin	Count
c9: lack of capacity to work collaboratively	Companies lack the ability and capacity to work collaboratively	from theory	7
c10: sustainability	Sustaining a network over a long period of time is difficult	from theory	3
c11: resistance to change	People are naturally resistant to change, and through them, companies are resistant to change	from theory	7
c: ASC	Related to company ASC	initial	10
c: CC	Related to company CC	initial	15
c: Customer	Related to a customer company of CC's or the customer of their customers etc.	initial	6
c: DC	Related to company DC	initial	13
c: MC	Related to company MC	initial	19
c: VMC	Related to company VMC	initial	5
communication between it and ot	Aspects related to the communication between employees or organisations that are well versed in either IT or OT	emerged	4
communication with customers	Aspects related to communication towards the customers of a network or organisation	emerged	6
data sharing	Anything related specifically to data sharing	emerged	12
dc1: protection of data	Data is valuable and needs to not fall into wrong hands	from theory	5
dc2: data provenance	Data needs metadata information and control over it to be valuable	from theory	5
dc3: value of data	The value of Data is difficult to define and prove	from theory	7
dig: changes competition	Perceptions that digitalisation changes competition between companies	emerged	7
dig: current state	The current perceived state of digitalisation	initial	13
dig: difficulties	The perceived difficulties brought on by digitalisation	initial	9
dig: from product to service	Perceptions that digitalisation changes the focus of organisations from products towards services	emerged	10
dig: possibilities	The perceived possibilites brought on by digitalisation	initial	8
km: within organisation	Knowledge management within an organisation	emerged	9
lvl: contractual	Challenges or facilitating factors related to the contractual level	emerged	6
lvl: funding	Challenges or facilitating factors related to funding	emerged	6
lvl: individual	Challenges or facilitating factors related to the individual level	emerged	7
lvl: network	Challenges or facilitating factors related to the network level	emerged	7
lvl: organisational	Challenges or facilitating factors related to the organisational level	emerged	12
lvl: technical	Challenges or facilitating factors related to technical issues	emerged	13

Name	Description	Origin	Count
n: towards value network	Perceptions of organisations moving towards forming value networks	initial	13
n: value chain management	Perceptions of organisations needing and gaining from value chain management	emerged	26
pm: pilot projects	Pilot projects as a tool for project management in data sharing transformations	emerged	6
pm: troubles	Perceived project management troubles in data sharing transformations	initial	9
shared understanding	Anything related specifically to forming a shared understanding	emerged	2
t1: efficiency vs. inclusiveness	Tension between efficiency vs. inclusiveness in a network	from theory	4
t2: internal vs. external legitimacy	Tension between internal vs. external legitimacy in a network	from theory	18
t3: flexibility vs. stability	Tension between flexibility vs. stability in a network	from theory	7
t4: unity vs. diversity	Tension between unity vs. diversity in a network	from theory	7
t5: sharing vs. controlling data	Tension between sharing vs. controlling data in a network	from theory	10
wrong assumption	A provably wrong assumption made by any interviewee	initial	1