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INDUSTRIAL INTERNET IN SUSTAINABLE VALUE CREATION OF COMPANIES

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AWS	Amazon Web Services
B2B	Business to Business
BM	Business model
BMC	Business Model Canvas
BSC	Balanced Scorecard
CPS	Cyber Physical System
CSR	Corporate social responsibility
GDP	Gross domestic product
GDPR	General Data Protection Regulation
IaaS	Infrastructure as a Service
ICT	Information and communications technology
IIoT	Industrial Internet of Things
IoT	Internet of Things
IPv6	Internet Protocol version 6
IT	Information Technology
KPI	Key Performance Indicator
M2M	Machine-to-Machine
ML	Machine learning
PaaS	Platform as a Service
SaaS	Software as a Service
SBSC	Sustainability Balanced Scorecard
SD	Sustainable development
SME	Small and Medium-sized Enterprises
SVP	Sustainable Value Proposition
TBL	Triple Bottom line of Sustainability

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ABSTRACT:

As we are heading towards a more digitalized world, an increasing amount of opportunities lies ahead of us. The Industrial Internet is described to have a large impact for industries around the globe. This research focuses on exploring its effects on sustainable value creation of companies. While the subject has gained a lot of enthusiasm over the last couple of years, the overall sustainable value creation elements of the Industrial Internet have not been studied properly due to its novelty. Yet, understanding the effects on how and where the sustainable value comes from is crucial in understanding the opportunities and challenges better.

The thesis is conducted by an extensive theoretical framework of the Industrial Internet phenomenon and its relevant sustainable value creation factors. The research is also done as a qualitative multiple case study to have a more in-depth understanding of the subject. The empirical findings represent five different top company personnel views, which have already implemented the Industrial Internet in their business processes. Different industry sectors were chosen to answer the research questions better and have a more comprehensive view of the issue. Furthermore, a theory-bound data analysis method is used to not only allow the comparisons to existing theory, but also gain the possibility to discover new information.

The results show the quality of the data and the combination of data sources to be the crucial elements in extracting value from data. While the Industrial Internet has allowed the companies to create sustainable value by improving their existing internal services and processes through monitoring and optimizations, the overall measurable short-term value it has created has not been that impactful at this stage yet. Although, improving existing services could have an influence on preventing potential value loss for the companies. However, the results also indicate that by providing external services, such as data analysis for customers can bring extensive short-term value when executed properly. The findings also demonstrated the Industrial Internet to allow new business partners and opportunities to be created, which would not have been possible had the investments not been made. Those new opportunities can bring a competitive advantage to the company by providing differentiation and better service levels to the customers.

While the results and implementations vary between the company, industry sector and expertise, the study can help companies to understand the opportunities and key factors behind the data better. The findings also help the companies that are discussing or in the process of implementing the Industrial Internet into their business processes to comprehend the crucial stages that need to be taken into consideration.

KEY WORDS: Industrial Internet, IIoT, Data, Sustainable value creation, Business models

1 INTRODUCTION

1.1 Background

Everything is becoming more digitalized as we move forward to the future with an increasing amount of opportunities that lies ahead of us. The adaptation of an Industrial Internet, also described as the Industry 4.0 (Müller & Voigt 2018: 660-661) is thought to be the next revolutionizing force for industries around the globe.

The Industrial Internet is used to describe the devices, sensors and different software's that are able to enable the connectivity between the machines (Wheatley 2013). This allows the creation of intelligent objects, which generate a lot of data. At its core, the Industrial Internet is about data and how to extract value from it (Greengard 2015: 54). The amount of created data has grown exponentially in the global scale over the years and is estimated to be around 175 Zettabytes by the year of 2025 (Reinsel, Gantz & Rydning 2018: 6). The amount of connected devices are also estimated to be over 20 billion worldwide by the end of 2020 (Gartner 2017; Cisco 2018).

Industrial Internet is believed to offer a tremendous amount of economic, ecological and social possibilities, which a lot of companies haven't fully adopted yet. According to a Yle report by Pantsu (2014), a research was made by MarketVision, which showed that 70% of the Finnish business executives were not utilizing the possible benefits of the Industrial Internet. As we move forward to the next industrial revolution, businesses should be aware of the new options that can create value to the companies.

The main contributors to the opportunities of an Industrial Internet include factors such as efficiency increases, cost savings, logistics improvements, new business models and environmental impact reductions (Evans & Annunziata 2012: 19-30; Hofmann & Rüsch 2017: 23-32; Bloom, Alsulami, Nwafor, Bertolotti 2018: 9; Müller, Kiel & Voigt 2018: 4). With evolving technology the amount of possibilities keeps on growing, but there is also a new wave of challenges ahead with the increased possibilities. The main challenging factors of an Industrial Internet includes investment and implementation costs, data security, legislation, standardization, employee qualifications and increased competition (Müller et al. 2018: 5; Bloom et al. 2018: 9; Müller & Voigt 2018: 664). As the concepts are new and developing, there is a lot of speculation on how strongly these effects will impact the companies that are utilizing the Industrial Internet. It has been argued, that the amount of jobs would also increase through the rise of the digitalization in companies (Evans & Annunziata 2012: 28; Hofmann & Rüsch 2017: 24). However, a number of studies (Bonekamp & Sure 2015; Beier, Niehoff, Ziems & Xue 2017: 232-233; Müller et al. 2018: 3; Müller & Voigt 2018: 664) indicate either no connection or a negative connection between the Industrial Internet and its effect on employee rates. While we can assume a number of new jobs to arise through certain needed requirements such as specific knowledge and monitoring, a lot of autonomous and simple tasks are expected to be replaced.

The new technology, uncertainty and potential sustainable impact on the whole world are the reasons it's extremely important to research the subject further. There is also a lack of research being done regarding the sustainable value creation effects on companies. Sustainability refers to a striving balance between the economic, ecological and social factors to meet the current needs without compromising the future (United Nations 1987; Mason 2015; Purvis, Mao & Robinson 2018: 1-3). These are also the main reasons for choosing this topic. The companies have an important role on their ability to incorporate the benefits of an Industrial Internet to their business models. The economic policies and business environments can determine the speed at which the gains can be seen on the global economy. (Evans & Annunziata 2012: 30.) The way we evolve and adapt to these changes can be a defining factor on how successful the possible outcomes are.

1.2 The aim of the research

The study focuses on the Industrial Internet and its sustainable value creation to the companies. The effects of the Industrial Internet are studied from an ecological, economical and social perspective, which are also referred as the triple bottom line of sustainability (Norman & MacDonald 2004: 243-245; Savitz & Weber 2014: 4-6). As current research and policies have mainly been focusing on the economic benefits of the Industrial Internet, more implications on sustainability is needed (Beier, Niehoff & Xue 2018: 2). Müller et al. (2018: 4-8) argues that the current literature has shown strategy, operations, environment and people as positive drivers towards the implementation of the Industrial Internet, where as the competitiveness and future viability, organizational fit, employee qualifications and acceptance are viewed as challenges. The severity of these effects also seem to vary between the industries, sizes and roles of the companies. Based on the literature, the possibilities and challenges are researched from the most crucial factors, as those can have the largest potential impact on the companies' sustainable value creation. The effect of sustainable value on companies is also studied, as it is crucial to the discussion.

The research is done by using a qualitative method. Five different companies in various industry sectors are interviewed to gain a wider knowledge of the Industrial Internet's value creation effects. As this study also analyses and compares the existing literature on the effects of the Industrial Internet, the companies that are being interviewed need to already have implemented at least parts of the technology. One of the goals is to also verify the potential value creation effects on the companies through performance measurements in order to gain reliable data. Otherwise a high level of skepticism should be used, since the authenticity of the data would be questioned.

The study is used to describe the correlation between the sustainable value creation and the Industrial Internet. Multiple different factors need to be taken into consideration, which makes the study both challenging, but motivating as well. There also seems to be a lot more studies done regarding the technical point of view, which makes the sustainable value creation aspect more desirable. The study's main concepts and terminology are defined properly in theoretical background section, so the reader gets a better understanding of the topic. While there are several different terms that can be used to describe the Industrial Internet, the main differencing factors are further discussed in the following chapter. Throughout this research, various terms are used depending on the context of the situation.

After a thorough study in the discussion section, a comparison is made between the scientific literature and companies in different industry sectors that have adopted the Industrial Internet. The information gathered by the companies is done by interviewing top Industrial Internet personnel. The thesis aims to answer the following questions:

1. How does the Industrial Internet affect the sustainable value creation of companies?

2. How does the sustainable effects and solutions of the Industrial Internet vary between the different companies?

The questions are worth studying, as the Industrial Internet could have an enormous impact on industries around the world and yet there is a lack of completed research done regarding the sustainable value creation effects on the subject. A lot of unanswered questions still remain, since the current scientific literature of the Industrial Internet is still mostly based on estimates and opinions. The companies are currently in the process of adapting the solutions provided by the Industrial Internet, so more data is also needed to compare the results with the previous studies.

2 THEORETICAL BACKGROUND

This chapter lays the groundwork for understanding the topic of Industrial Internet and sustainable value creation. Furthermore, the presentation and terminology of the relevant factors behind the subject is introduced and discussed.

2.1 Internet of Things

The Internet of Things (IoT), also referred as the Industrial Internet of Things (IIoT) in an industrial setting, is being known as a communication process, where technologies such as sensor- and wireless technology are being embedded into existing and new devices to recognize themselves to other devices in order to generate large volumes of data (Höller, Tsiatsis & Mulligan 2017: 64; Boyes, Hallaq, Cunningham & Watson 2018: 2-4).

A specifically built in network allows all devices to be connected to different wireless technologies. Meanwhile, the network is also connected to a software application, that is able to work in a semi-automated or automated way, which is able to process and analyze the incoming data and transmit it to other devices to perform specific actions based on the data. (Miller 2015: 8-9, 16-17.) In a more practical example, the IoT technology allows sensors to monitor not only devices, but the environment changes as well. The sensors could therefore monitor the optimal temperature setting while transmitting the data to other devices to perform specific corrections automatically, when it notices even the slightest differences in optimal levels. (Miller 2015: 9; Ramesh, Sankaramahalingam, Divya Bharathy & Aksha 2017.)

While the specific meanings may vary between the terms, they are often treated as synonymous between each other. The IoT term itself can be thought of as the physical world that is being combined with the digital world, while the Industrial Internet describes the different systems that enable the connectivity between the machines. (Wheatley 2013; Boyes et al. 2018: 2-3.) Although the first use of the phrase "Internet of Things" was argued to be used in a title of a presentation in 1999 by Kevin Ashton (2009), the history of the IoT concept itself was discussed as early as 1982 for a modified Coke machine (Carnegie Mellon University 2014). While there have been connected devices years ago, the amount was fairly low compared to today's world. In fact, the IoT definition itself didn't exist on paper in 2003, even though there were 500 million devices connected to the Internet at that time. Instead, the IoT was estimated to be "born" between 2008 and 2009, when the amount of connected devices surpassed the amount of people. (Evans 2011: 2-3.)

It is also worth noting, that the different IoT strategies for enterprise, commercial, consumer and industrial forms of the Internet may vary a lot from the concept of the IoT, as the target groups, strategies and technical requirements can be vastly different from other markets. The Industrial Internet of Things (IIoT) however, holds the most potential in terms of overall economic impact, as it produces the majority of global gross domestic product (GDP) and companies are still in the early stages of adopting the Industrial Internet. (Gilchrist 2016: 1-3.)

Yet, in order to fully gain the potential of an IoT system, a three-stage development process need to be adapted. These include the installation and connection of the IoT devices, enabled connectivity between two or several devices in order to function together and creating intelligent applications that are able to analyze the data to initiate specific actions. (Miller 2015: 17-20.)

2.2 Industry 4.0

The term Industry 4.0, or at that time "Industrie 4.0" was originally adopted in 2011 by the German government as a strategic initiative to assure future competitiveness of its manufacturing industry (Kagermann, Wahlster & Helbig 2013: 77). It was a possibility for the German manufacturing to contribute in formulating the next industrial revolution by capitalizing new business models, optimizing logistics and production. The Industry 4.0 is being described as the fourth industrial revolution or a "smart factory", which includes the systems and technologies behind the IoT solutions. Nowadays the Industry 4.0 stands for the digitalization of manufacturing (BMBF 2016; Müller & Voigt 2018: 660-661.), where as the term digitalization can be described as creating additional value through digital technology applications (Luhtala 2018; Laudien & Pesch 2018: 3).

In the core of an Industry 4.0 are the intelligent systems, automation, virtualization and sensor-driven connected networks that push towards the early stages of the fourth industrial revolution. The combination of artificial intelligence (AI) and machine learning (ML) allows machines to resemble human behavior such as problem solving and learning automatically without human interaction. (Aerotek 2017.) Figure 1 summarizes the industrial revolutions at different points of time, as well as the key factors behind the transformations.

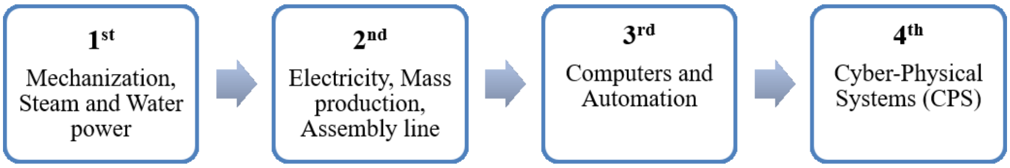

Figure 1. The Industrial revolutions adapted from Aerotek (2017).

While the industrial automation could be linked with cyber-physical systems (CPS) of an Industry 4.0, the main difference is their relation to data. CPS are combinations of networking, computation and physical processes, where they can be monitored and controlled constantly via embedded computers. Moreover, CPS allows the software's to merge with the virtual computers' digital world. (Gilchrist 2016: 35-38.) The whole concept of the Industrial Internet focuses on data, which allows the real-time information flow between the machines and systems. Therefore, the CPS are able to be build, as the smart devices, people and environment are connected together to the whole communication infrastructure. Machine-to-Machine (M2M) then allows the different systems to communicate between each other due to that data. (Collin & Saarelainen 2016: 32-33, 48-50.) Although the Industrial Internet and Industry 4.0 are often viewed as synonymous, the main differing factors focus on the primary sectors and value chains. Whereas the Industry 4.0 mainly focuses on the manufacturing, the Industrial

Internet covers all industrial sectors. The Industry 4.0 also covers the complete digitalization value chain. (Sontag 2018.)

2.3 Cloud computing

Cloud computing describes the availability of web-based computers, assets and services, which can be used to implement various complex web-based systems (Jamsa 2013: 1-2). It essentially is the IT's replication of a renting model, where the users are able to pay only for the resources they use (Jamsa 2013: 2-3; Fehling, Leymann, Retter, Schupeck & Arbitter 2014: 1-3).

Cloud computing, as many other technologies have been around for years, but it really came forward as a format in the last decade through the popularity of Amazon Web Services (AWS). Amazon's initial goal was to build enormous data centers to meet the specific web-scale requirements. As the cloud model was highly successful, other companies such as Google and Microsoft also followed after that. (Jamsa 2013: 5-12; Gilchrist 2016: 47.) As the cloud is able to offer resources to run own data centers without involving large amount of capital or operational expenditure, it has become extremely popular nowadays for many businesses. Cloud computing is also an integral part of the Industrial Internet, as it is able to provide economically viable technologies to gather, store and analyze data. (Gilchrist 2016: 17, 47; Cinque, Russo, Esposito, Choo, Free-Nelson & Kamhoua 2018: 31.)

The cloud-based systems include deployment models, which define the sharing of the resources within the cloud. The primary models are described as public-, private-, hybrid- and community clouds. Public clouds are accessible to the public and is often the cheapest solution, yet the least secure. Private clouds are available for specific groups or institutions, offering more security at a larger cost. Hybrid clouds combine at least two or more other cloud deployment model solutions together. Community clouds describe a shared and accessible cloud within certain organizations. (Jamsa 2013: 5-6; Fehling et al. 2014: 60-78.)

Through the gained popularity of cloud computing, a number of new innovative provisioning models have aroused for the companies to be used. These are called Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Each of the models describes a different service for companies and customers. IaaS consist of physical and virtual machines to be made accessible through the Internet. PaaS allows the building and deploying of applications such as databases and Web servers. SaaS consist of the cloud's application software to be made available on a monthly basis. (Gilchrist 2017: 32-33; Cinque et al. 2018: 32.) These models have allowed businesses to be able to rely on cloud-based services as a cost-efficient way to move their applications and non-critical services by only paying by the usage (Gilchrist 2017: 32).

2.4 Big Data

The use of the term Big Data has been growing rapidly in the past few years. Although its usage, there seems to be no definite definition. While Big Data has been predominantly associated with old concepts such as data analysis and data storage, its actual term varies a lot more. The term "Big" would imply significance, challenge and complexity, but at the same time it also implies quantification. (Ward & Barker 2013: 1.) However, the significance of the size is often not the defining factor for Big Data. It seems to naturally grow in larger volumes, as enabling factors in ICT allow that to happen. (Xu, Cai & Liang 2015: 205; Perera, Ranjan, Wang, Khan & Zomaya 2015: 32.)

Ward and Barker (2013) were able to survey a wide variety of big data definitions from multiple sources. They notably found that all definitions had at least one of size, complexity or technology as the defining factors. In the context of Big Data, size refers to the volume of the datasets, while complexity and technologies refer to the structure and techniques of the datasets. Based on those factors, they proposed a following definition: *"Big data is a term describing the storage and analysis of large and or complex data sets using a series of techniques".*

Since the definition is broad, it still holds as of today. For more specific proposed definitions of Big Data, similar aspects have been found critical by several researchers. Big Data's main concepts and characteristics are often described as three V's, or sometimes as four V's, which describe volume, velocity, variety and veracity. (Perera et al. 2015: 32; Gilchrist 2016: 52-56; De Mauro, Greco & Grimaldi 2016: 130-131.)

While the amount of data described in the context of Big Data is too large for the ordinary processing tools and databases to handle, the data structure itself can be seen in different combinations such as text, form, comments, telemetry, GPS tracks, videos and so forth (Gilchrist 2016: 52). The data is generated from both structured and unstructured data, which describe used data sets inside and outside of a database (Greengard 2015: 44). In order to fully gain the benefits of an IIoT such as efficiency improvements and customer trends, companies have to analyze the data from all sources in structured and non-structured ways. Nowadays, it is seen as a common practice for companies to store all the data, as programmed software's are able to extract distinct value from the data. As the IIoT is a major contributor for Big Data through the sheer amount of data generated through sensors communicating back and forth with other devices, it requires modern technologies to deal with the large and unstructured data. Therefore, the type of usage in technologies depends on the type of Big Data that is available. (Gilchrist 2016: 52-56.)

2.5 Sustainable value creation

Bowman and Ambrosini (2000) argued that the term "value" can take the form of:

> Perceived use value that is subjectively assessed by the customer who uses consumer surplus as the criterion in making purchase decisions and Exchange value, that is the price paid for the use value created, which is realized when the sale takes place (Bowman & Ambrosini 2000: 13).

Consumer surplus implies to the perceived value of goods in the eyes of a consumer, which is often referred as "value for money". It can be increased or decreased by modifying its perceived value. Therefore, the price can be increased or reduced while still maintaining the same amount of total monetary value. (Bowman & Ambrosini 2000: 3-5.)

Figure 2 summarizes the process of value creation. The new use value is created by the acts of the members of an organization. The use value is then produced by the combination of received use values by labor. The exchange value is realized, when the sale happens. In order to gain added exchange value, meaning profit, the realized exchange value on sale needs to be higher than the cost of process input. (Bowman & Ambrosini 2000: 8.)

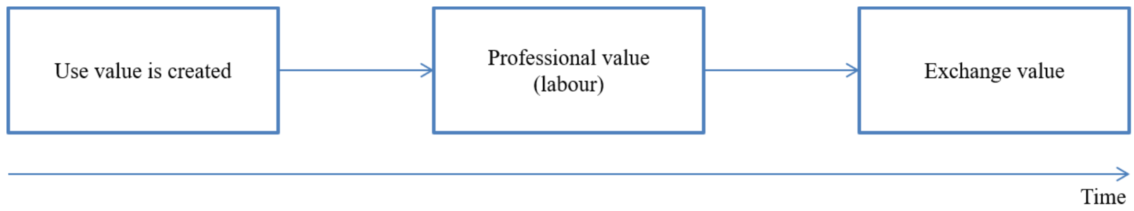

Figure 2. The process of value creation adapted from Bowman & Ambrosini (2000: 8).

The approach of sustainable value creation takes also the environment and society into fundamental parts of the processes, where positive contributions can be made towards the global goals of sustainability (Stock, Obenaus, Kunz & Kohl 2018: 258). The global goals describe the United Nations main concepts behind the sustainable development (United Nations 1987). The concept, as described in the introduction, refers to a striving balance between the economic, ecological and social factors to meet the current needs without compromising the future (United Nations 1987; Mason 2015; Purvis et al. 2018: 1-3).

Stock et al. (2018) summarizes sustainable value creation to describe a process of value creation:

- *Which considers the three dimensions (environment, society, economy) as a structure for fundamental and integrative solution areas;*
- *which makes a positive contribution to current global sustainability goals;*

- *which incorporates the sustainability principles by applying suitable measures to develop business models, value creation networks, as well as value creation modules;*
- *which is fundamentally aimed at securing and improving competitiveness* (Stock et al. 2018: 258.)

The approach of the main economic, ecological and social factors are often described as the Triple Bottom Line of Sustainability (TBL) or as the three pillars of sustainability (Purvis et al. 2018). In this thesis, we refer to the TBL when describing those factors, as that seems to be the more common term used in this area of work regarding the sustainability. The TBL addresses sustainable development (SD) and corporate social responsibility (CSR) as part of the companies’ agenda (Henriques & Richardson 2004: 1-3).

3 SUSTAINABILITY IN BUSINESS VALUE

This part of the theoretical framework introduces the more in-depth sustainable value creation elements of the study. As the topic is extensive, the chapter highlights the most relevant factors in relation to the Industrial Internet and the overall digital transformation.

3.1 Sustainable value and development

In order to create long-term systems and visions, it is crucial to have sustainability. There is also a large demand and focus for the companies to make a shift towards more sustainable strategies, as it is becoming more apparent to the overall future success of a company. In the recent decades, high-sustainability companies have often greatly outperformed the low-sustainability one's financially as well. (Eccles, Ioannou & Serafeim 2012; Alshehhi, Nobanee & Khare 2018: 13.) While Barnett (2007) argues the effects of those to vary between the companies and often has no impact on financial performance, it also depends whether the resources are put into more profitable sustainable operations (Alshehhi et al. 2018: 2).

However, currently we live in a world where people are more ecologically and environmentally conscious, which makes emphasis on companies' social responsibilities that much more important. A lot of today's business models still focus on creating, delivering and capturing value without paying too much attention on social or environmental values (Evans, Fernando & Yang 2017: 203-204). That can however change, as there are a lot more pressure put to government and parliament measures such as strict climate actions in the European Union (European Commission 2019). While economic growth is essential, the core concept of sustainable development, developed and discussed already in 1987, strives to find a balance to recognize and satisfy the current basic needs without damaging the future generations (United Nations 1987).

Hart and Milstein (2003: 58-60) argues a set of global drivers for creating sustainable value. These are divided into internal and external factors of the current and future strategies. The internal factors include pollution prevention strategy, which creates value through cost and risk reductions and the future strategy of developing clean technology, which value is through innovation and ecological impact. The external factors include developing a more transparent business processes, which help with the connection between the customers in creating a better reputation. The fourth strategy is developing a roadmap of overall sustainability for the future in a way, which contributes to the overall wealth creation of humanity.

Meanwhile, Evans et al. (2017: 204) argued that the current literature views whole system design techniques and system thinking as a crucial way in understanding sustainable value. In that context, systems design refers to the whole system and its optimization, where it satisfies the specific requirements. While it offers great potential, its processes and approaches have not been understood or defined correctly yet. Systems thinking refers to a technique in understanding the interactions and relationships between the various parts of a system better. (Evans et al. 2017: 203-206.)

As opposed to understanding value only as a monetary term, comprehending the whole sustainability requires a much broader view. Figure 3 describes the essential core of sustainable value, which requires a consideration on each one of those categories. It is also essential to identify, that as value can be visible, invisible, missed, captured or un-captured, new opportunities can be provided with sustainable actions. Therefore, adding sustainability focus on companies can be a competent approach into combating potential forms of un-captured value. (Yang, Vladimirova & Evans 2017: 31-33.)

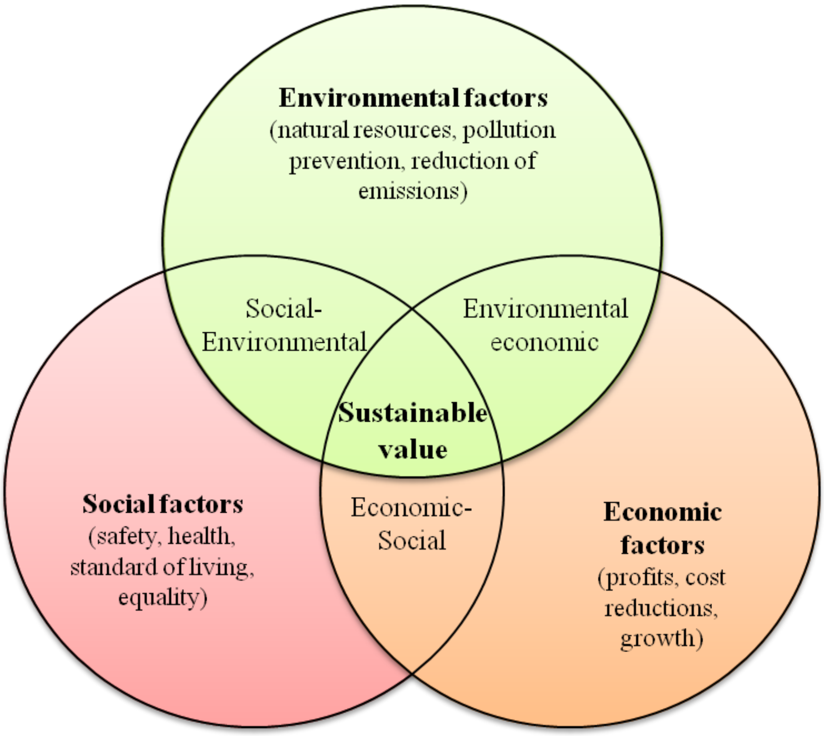

Figure 3. The elements of sustainable value adapted from Yang et al. (2017: 32).

The Industrial Internet can also produce products and services, which help towards a more sustainable world. As the CEO of Philips, Frans Van Houten (2013) explained in the Royal BAM Group press release, the transition towards a circular economy is necessary in order to have a sustainable world. The more effective use of natural resources, recycling and ecosystems would not only have an ecological impact, but a large economic effect as well. The main driver behind the concept is also to push towards the innovation of component-, material- and product-reuse. The more effective and lower usage of materials also allows the companies to create more value.

3.2 Business models

Zott and Amit (2013) argued that Business models (BM) create value through different methods such as efficiency, complementarities, novelty and lock-in. These describe the theoretical roots of the developed BM, as they focus on integrating these to emphasize the understanding of different mechanics and processes that drive value creation. The BM design has been empirically shown to be one of the key factors for value creation.

Nowadays, researchers have come into the same conclusions around the common themes of the BMs. These are: BM value-centered logic, where value is created not only for the critical business, but all stakeholders. Activities, which are performed by the critical company such as suppliers, partners and customers. A comprehensive approach to emphasize how companies are able to do business and the emergence of BM as a new unit of analysis. (Zott & Amit 2013: 403-404.)

However, Arend (2013: 391) argues that there is no established BM concept and the commonly used BM term as a *"description of how a traditional value operates"* is weak from a theoretical standpoint. This also seems to be the consensus amongst many other researchers regarding the standpoint that there is no solidified commonly agreed BM idea yet (Johnson 2010: 6; Zott & Amit 2013: 404-405; Pisano, Pironti & Rieple 2015: 184, 195-196). Instead, the companies often end up developing the best ideas behind BMs regarding their specific requirements through trial and error (Pisano et al. 2015: 183-196).

Gassman, Frankenberger and Csik (2013) describe a conceptualized tool, as seen in the Figure 4, that consists of four different dimensions. These describe certain detected patterns which data is gathered from a large number of BM cases by the University of St. Gallen. However, innovating BMs with tools such as Business Model Canvas (BMC) focuses primarily on economic value instead of also taking into account the usage of sustainability. While The Value Mapping Tool takes sustainability functions into consideration, it does not address a proper value concept in relation to sustainability. (Yang et al. 2017: 31.) Nevertheless, Joyce and Paquin (2016) have argued a triple layered BMC tool for innovating sustainable focused BMs, which expands the TBL factors into the design process. Those include environmental life cycle and social stakeholder BM tools as a part of the traditional economic tool as well. Furthermore, traditional BM tools can also be modified to support the sustainability agenda as well. However, in order for sustainability to generate value creation opportunities, a proper framework need to be developed. Therefore, sustainability focused BMs demands the companies to connect the outcomes and resources beyond multiple stakeholders, such as satisfying the customer needs and making positive contributions to all TBL factors. (Yang et al. 2017: 30-33.)

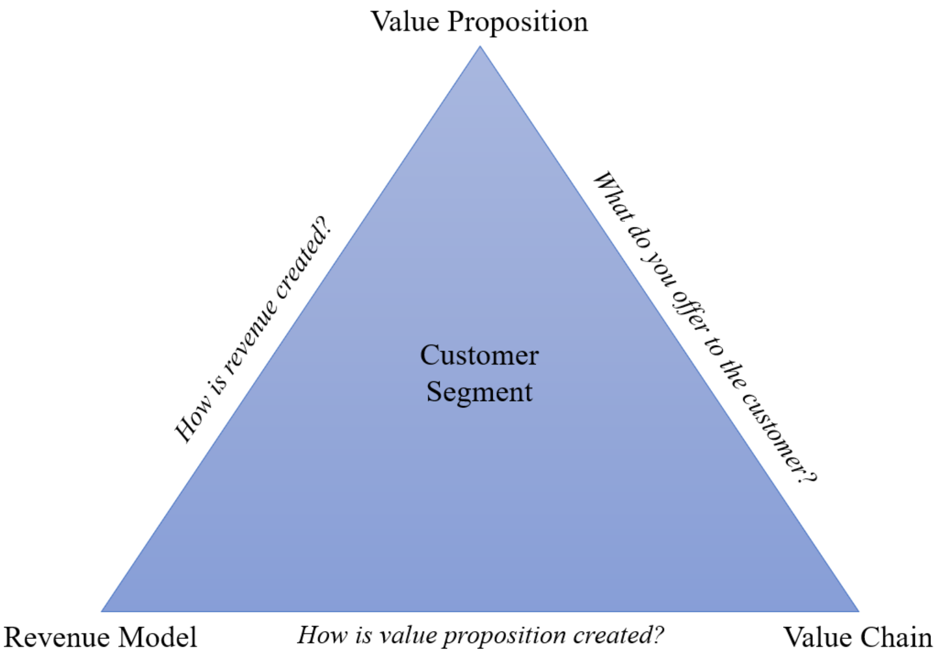

Figure 4. BM definition – the magic triangle adapted from Gassman et al. (2013: 2).

With the digitalization of the companies and the Industrial Internet, BMs are also changing and transforming the ways of the whole sustainable value creation. Ibarra, Ganzarain and Igartua (2017: 7) proposes different approaches such as customer and service orientation and networked ecosystems, which have been identified and suggested by previous literature. However, the effects of the BMs in the Industry 4.0 era can be identified in several different ways to transform the current BMs:

- The innovation of value creation and value delivery to improve existing BMs
- The re-handling of value networked ecosystems to diverse the actual BMs
- The "smart" products and services through digitalization for new BM typology (Ibarra et al. 2017.)

The traditional approach of BM design describes the organizations ability to create, deliver and capture value (Schneider, Mittag & Gausemeier 2017: 117; Ibarra et al. 2017: 7-8). Following the transformation effects of BMs, companies need to find more ways to improve their traditional BMs as well as create new one's for different purposes (Ibarra et al. 2017).

Figure 5 describes four key ways for companies to create, deliver and capture value through the improvements of new and traditional BMs. The transformation of the processes can be achieved through digitalization and changes in new technologies such as Additive Manufacturing, Artificial Intelligence (AI), Big Data and Cloud Computing (Ibarra et al. 2017: 7-9).

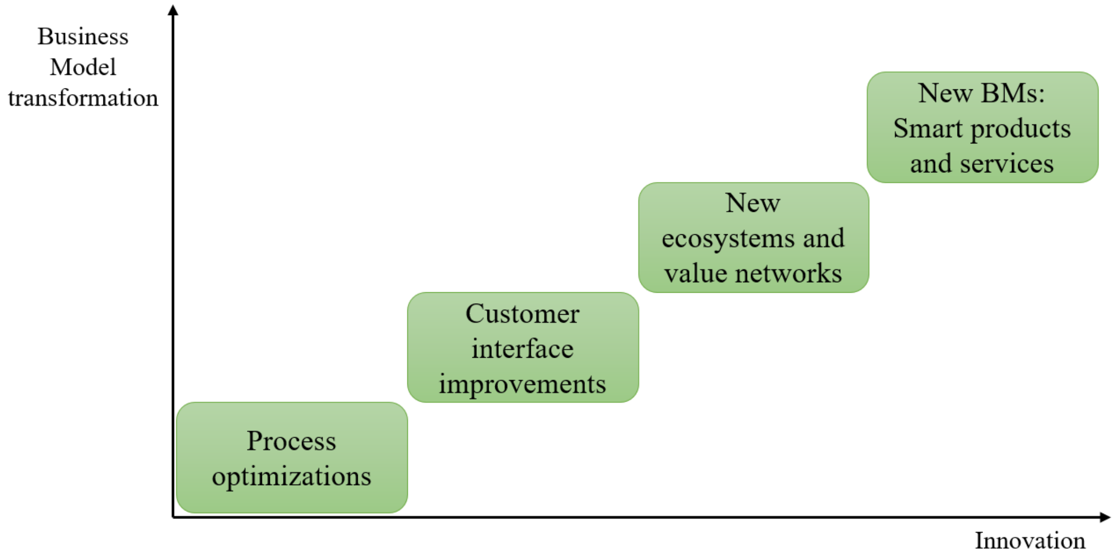

Figure 5. Four ways to conduct digital transformation in manufacturing companies adapted from Ibarra et al. (2017: 8).

3.3 Sustainable value propositions

Value propositions are the set of experiences and values that companies promise to deliver to their customers (Golub, Henry, Forbis, Mehta, Lanning, Michaels & Ohmae 2000; Hassan 2012: 82-83). Sustainable value propositions (SVPs), similarly to the TBL approach, emphasizes the economic, ecological and social factors that the companies' offerings deliver to the customer's and the whole society (Patala, Jalkala, Keränen, Väisänen, Tuominen & Soukka 2016: 144). The concept of SVP was introduced to lead a longer-term perspective on the development of products (Seevers 2014: 57).

Understanding sustainable value propositions is in the core of sustainable BMs, as it is the combination of several needs that can create divided value across multiple stakeholders (Bocken, Short, Rana & Evans 2013: 483-484; Baldassarre, Calabretta, Bocken & Jaskiewicz 2017: 177). Moreover, companies need to be able to work together within supply chains to tackle the sustainability issues (Patala et al. 2016: 153). Therefore, a holistic view on SVP need to be developed, where the customers associated costs and benefits are shared between the wide range of various stakeholders (Bocken et al. 2013: 484). The combination of shared generated value between stakeholders, overall sustainability problem assessments and developing solutions, such as products or services to help combating those issues by also taking the shareholders into consideration are argued to be the key factors of SVPs (Baldassarre et al. 2017: 176-178).

Patala et al. (2016) proposes a SVP development process as seen in Figure 6, which is based on their empirical findings and previous existing studies. The identification stage recognizes key features that an offering can provide, which describes the TBL dimensions as well as the customer's specific needs. The indicator stage describes the process of specifying the relevant indicators to determine the value that an offering provides. Life-cycle modeling quantifies the TBL dimensions, where the impact results of the offerings whole lifecycle can be analyzed. Calculating the life-cycle value then describes the realized customer's total value. (Patala et al. 2016: 148-151.)

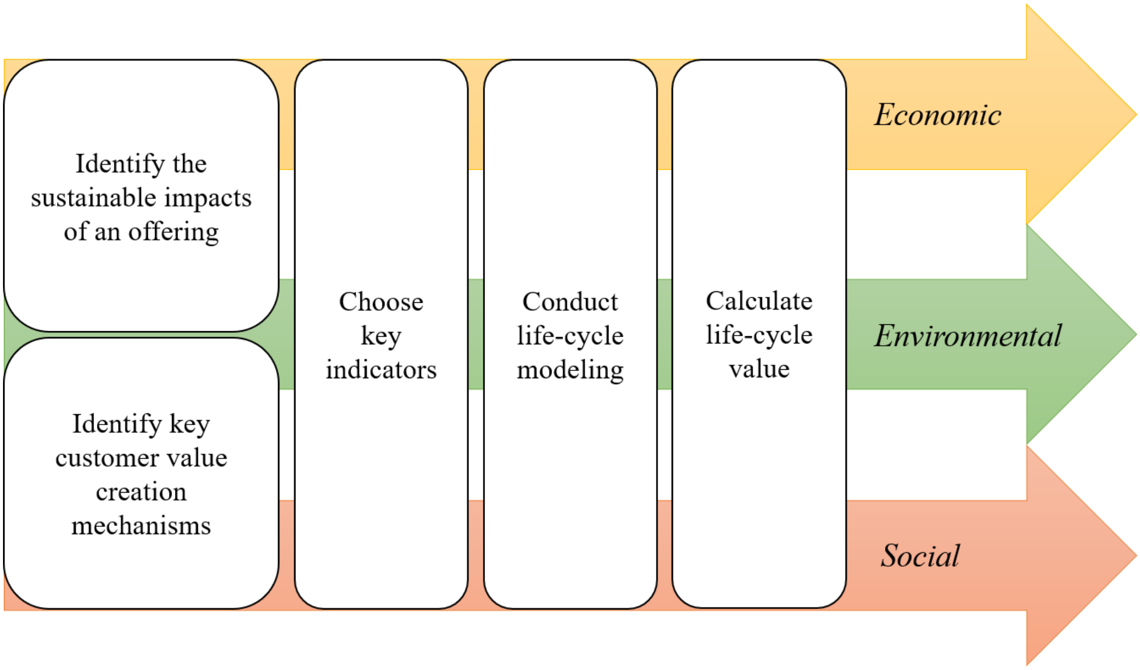

Figure 6. Proposed framework for SVP development adapted from Patala et al. (2016: 149).

With the emerging digitalization of services and products, the perceived global value tends to be significantly lower than a physical alternative of a similar offering. However, digitalization can offer a multitude of benefits, which are able to affect its perceived global value positively. (Abaidi & Vernette 2018: 679-683.) While some indicators, such as the social and environmental ones, do not necessarily correlate between the customer value, they do provide additional benefits to the whole society and thus, are able to complement the economic aspects as well through good-will and improved safety. Nevertheless, collaboration between the companies and different supply chains are needed for the TBL effects of products and services to be determined. (Patala et al. 2016: 149-153.) Seevers (2014: 21-31) argues the improvement on SVPs to also increase product utilization and warranty rates. Yet, the main problem as he puts it, is to overcome all the different components to satisfy all the sustainability goals as well.

3.4 Sustainable performance measurements

In order to demonstrate a sustainable value, or any value to that matter, it needs to be quantified through various performance measurements. We are at the point, where the performance measurement systems have evolved in several different phases. At the beginning, the systems were mainly focused on economic indicators, whereas now the awareness of other factors has become more and more apparent. While it can be questioned on how large of a contribution sustainability indicator’s make to an actual business performance, certain correlations have been identified with the additions of positive economical and social indicators. (Rajnoha, Lesnikova & Krajcik 2017: 121-124.) However, while positive ecological and social indicators are often in correlation with each other, companies' economic indicators do not have an equal effect on those (Hourneaux Jr, Gabriel & Gallardo-Vázquez 2018: 418-426).

One of the most valued and well-known measurement- and management system for businesses, the balanced scorecard (BSC), was developed in the early 1990s (Kaplan & Norton 1996). BSC introduces a framework of long- and short term financial and non-financial measurements for businesses to understand the goals and methods they need to succeed in the competitive and complex market environments, as seen in Figure 7. Instead of highlighting the already achieved financial objectives, BSC also introduces other measurement drivers of financial performance. These measurements are divided between the customers, internal business processes, learning and growth, striving for a balance between the four objectives in businesses vision and strategy while still maintaining an economic focus. (Kaplan & Norton 1996: 2-40.) Nowadays, it has been widely adopted by most large enterprises in the world (BSC Designer 2019).

However, a survey conducted by Bain & Company (2018) shows a steady decline on its total usage over the past years, despite maintaining its satisfaction levels. It could be questioned, whether its declined usage is due to sustainable factors becoming more apparent, better measurement systems being available or not being recognized as a framework of BSC with its modified usage. While BSC is still the backbone of the overall measurement systems, it should be adapted to serve the individual organizations needs to fully gain its effectiveness (Kaplan & Norton 1996: 285-286; Macnab, Carr & Mitchell 2010).

Kaplan & Norton (1996) argued a set of strategic measurements for each of the BSC categories (Figure 7). The financial perspective can be divided into growth, sustain and harvest, which includes a set of measurement themes such as revenue growth, cost reductions and asset utilization (Kaplan & Norton 1996: 48-58). Customer measurement groups can be divided into market share, satisfaction, retention, acquisition and profitability. However, key measurements such as customer satisfaction rates, reputation and the attributes of a product or service can be described as lagging measurements, referring to the fact that the quantifiable data will become available when it is too late to change the outcome. (Kaplan & Norton 1996: 67-85.) The internal business process model describes innovation, operations and post-sale service as the key factors. These include measurements such as productivity rates and quality of processes such as defect rates, scrap and waste. The innovation performance of internal business processes describes a set of tools to measure innovation ranging from percentage of sales of new products to the time to develop them. (Kaplan & Norton 1996: 96-116.) Finally, learning and growth perspective includes the capabilities of an employee and information systems as well as motivation, empowerment and alignment. The employee performance can be measured with their productivity, satisfaction and retention. (Kaplan & Norton 1996: 126-146.)

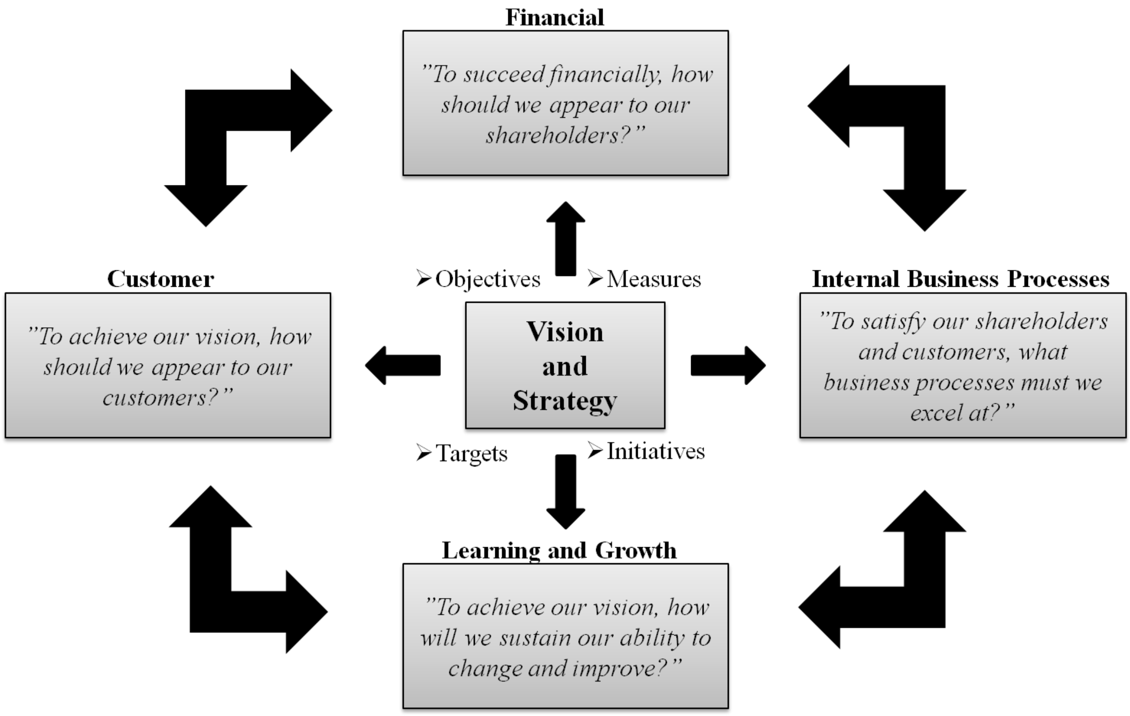

Figure 7. The Balanced Scorecard Framework adapted from Kaplan & Norton (1996: 9).

Whereas, Hourneaux Jr et al. (2018) argues a set of sustainable performance measurements for industrial companies (Table 1), which describe the typical important and high-priority indicators related to the main aspects of TBL. While its economic dimensions are adopted by the BSC framework (Hourneaux Jr et al. 2018: 415), it is also interesting to note, how BSC resembles the other TBL measurements in some aspect's despite not being recognized as a sustainable model. As sustainability is an important issue of today, researchers and practitioners have argued modifications to the original BSC to include sustainability as the fifth aspect, referring to a sustainable balanced scorecard (SBSC) (Hansen & Schaltegger 2016). However, while some TBL indicators may not translate properly into quantifiable customer value, they may still provide benefits to the environment and society (Patala et al. 2016: 149).

Table 1. Triple Bottom Line performance measurements and indicators adapted from Hourneaux Jr et al. (2018: 420-422).

Economic Dimension	Environmental Dimension	Social Dimension
Return on equity	Materials and resources	Labour/management relations
Number of customer complaints	Energy	Safety and health
Customer satisfaction rate	Water	Training
Materials efficiency variance	Transporting	Equal opportunity
Return on investment	Emissions, effluents and waste	Freedom of association and collective bargaining
Labour efficiency variance	Environmental aspects of products and services	Employment
On-time delivery	Environmental compliance	Marketing communications
Number and time to market of new products	Biodiversity	Security practices
Rate of material scrap loss	General environmental issues	Community

Key performance indicators (KPIs) are the key indicators, which focus on the most critical issues of today and the future performance of the organization (Parmenter 2015: 7-8). Kaplan & Norton (1996: 162-163) argues no more than two dozen of key measurements for businesses, as otherwise the BSC would become too complicated and not being able to function properly. Lower amounts of KPIs should also be used in smaller organizations. Parmenter (2015: 19-20) argues that up to ten KPIs should be used within organizations, while often a significantly lower number would be more suitable. However, KPIs are not the only performance measurements businesses use. As KPIs are the most critical factors that define the overall success of an organization, other indicators should also be used to measure smaller elements such as an individual team's success. Therefore, measures can be divided into regular and key types, indicating key result- and performance indicators as well as regular result- and performance indicators. (Parmenter 2015: 3-20.)

In the Industrial Internet era, analyzing the complex automation systems with KPIs can be a challenge. Höller et al. (2017) argues two defining factors with the IIoT use cases as following:

- The evaluations can be conflicting, unreliable and subject to changes
- The costs in adapting the solutions need to be accounted for

However, the tradeoffs with the IIoT cases are hard to measure, such as the risk and cost returns, as they will progress over time, making decision preferences difficult to describe calculatory (Höller et al. 2017: 70).

4 INDUSTRIAL INTERNET

This chapter introduces the TBL elements of the Industrial Internet, as well as the most relevant opportunities and challenges adapted from Müller et al. (2018) of the current scientific literature.

4.1 Sustainable impact

4.1.1 Economic

Since the Industrial Internet as a concept is still rather new, there has been a growing amount of research being done regarding the subject. However, lack of studies regarding its real effects on companies prevail. It is still unclear, which sustainable impacts are relevant and how those affect the companies using these technologies. Although the Industrial Internet is argued to achieve economic, ecological and social benefits such as the previous industrial revolutions have done (Evans & Annunziata 2012: 19-30; Müller et al. 2018: 2-8), the amounts of these effects seem to be widely based on assumptions and opinions.

The Industrial Internet is argued to have a large economic impact, which is achieved through multiple different components such as cost savings, production growth and increases in efficiency (Evans & Annunziata 2012: 3-4; Greengard 2015: 56; Kiel, Arnold & Voigt 2017a: 4-5; Schaeffer 2017: 79; Müller et al. 2018: 4; Beier et al. 2018: 6-10). However, the short-term profitability of implementing the Industrial Internet is also often negative, due to the high initial investment costs (Birkel, Veile, Müller, Hartmann & Voigt 2019: 9). The executions of the investments to the technology is also hard and often takes more time than anticipated (Houghton 2017). The uncertainty raises the risks associated with the Industrial Internet and has often been a large factor on companies' hesitance to fully commit to the technology (Kotler, Armstrong & Parment 2016: 148).

Nevertheless, the overall economic impacts could be groundbreaking. In the future, many consumers and businesses may opt to buy outcomes instead of the physical hardware's. This also describes the Outcome Economy, where manufacturers are able to sell services based on the products itself. In other words, an outcome as a result will be bought instead of an actual product. (Gilchrist 2016: 10; Schaeffer 2017: 55.) Another aspect that can be seen with the Industrial Internet in the future is the rise of a Pull Economy. This describes the combining of a product only when an order has been set, thus optimizing the production, energy and resource usage (Schaeffer 2017: 75.) Figure 8 demonstrates the four likely paths for the evolution of the Industrial Internet. Operational efficiency, new products and services represent the first path of opportunities that can be seen today. Outcome-Based Economy and Autonomous Pull Economy describe the longer-term paths and goals, which are in the process of being adopted by the mainstream in the future. (WEF 2015.)

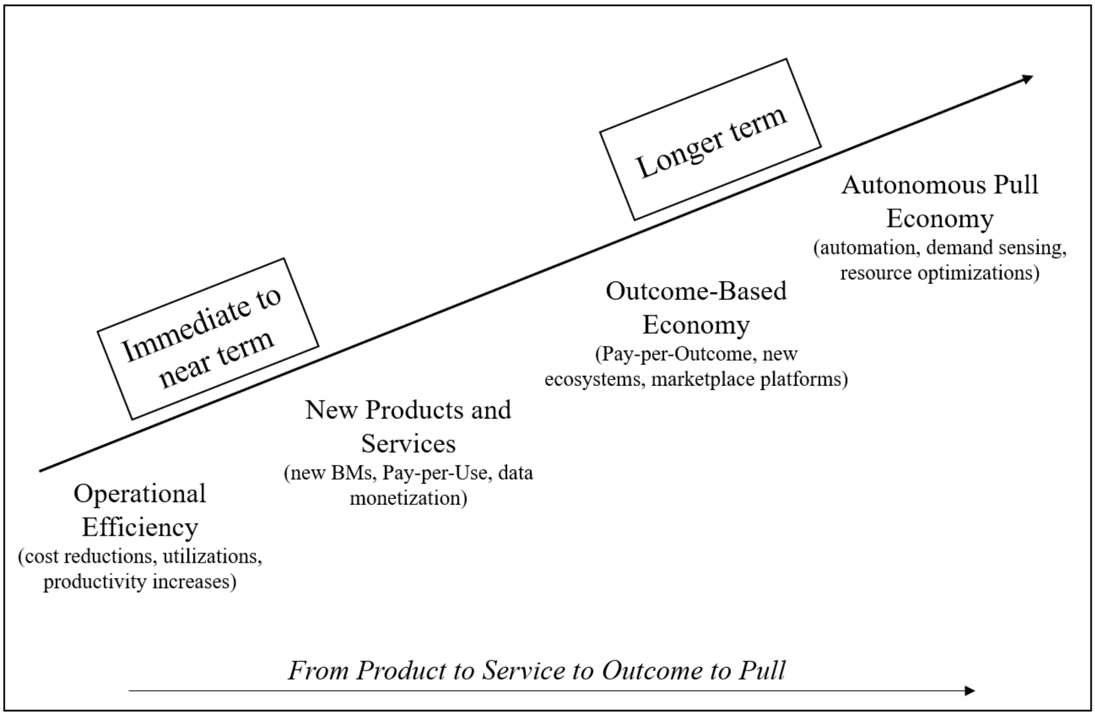

Figure 8. The adoption and impact path of the Industrial Internet adapted from WEF (2015).

Evans and Annunziata (2012: 3-4, 7-13) have argued that even small improvements on operational cost savings and system efficiency improvements can lead to significant gains. The term *"the power of one percent"* originally came up in a General Electric meeting in 2011 to explain the value propositions of the Industrial Internet for customers (Comstock & Raz 2018). It has also later been adopted by other professionals (Evans & Annunziata 2012: 19-30; Leonard 2015; Gilchrist 2016: 4) to demonstrate the potential figures in the context of an Industrial Internet. Therefore, a one percent of fuel savings in an aviation industry would be estimated to amount of $30 billion over 15 years. Similarly, a one percent efficiency gain in the healthcare industry would amount to $63 billion in savings. (Comstock & Raz 2018.) The annual productivity rate could also be boosted by 1-1,5 percentage points annually based on previous Internet revolution peaks. The Industrial Internet is also argued to bring the largest of the Industrial revolution gains yet. (Evans & Annunziata 2012: 3-4.)

However, since the basis of those numbers was to provide an easy and understandable way to describe the potential economic impact of an Industrial Internet (Comstock & Raz 2018), we should be highly skeptical about the authenticity of those arguments and figures. While there is a relatively valid reason to estimate those values due to the total cost savings and efficiency improvements the Industrial Internet could provide, the ultimate effect on new technologies can be hard to predict. Ehret and Wirtz (2017: 117) argue that in the case of an Industrial Internet, a large amount of research has been done in the technology management field to show examples of technological promises not being able to transfer into business performance properly. Nevertheless, in the recent years the benefits have also started to emerge as major industrial companies, such as General Electric and Bosch Rexroth have set goals to realize over $1 billion in productivity goals by the year of 2020. General Electric reached that goal in 2017, crediting the Industry 4.0. (Geissbauer, Schrauf & Pullsbury 2018.) Although there is still uncertainty on how much of the productivity gains can be credited to the Industrial Internet, the results look promising. Yet, the implementation of the Industrial Internet also requires large investments, meaning the total economic impact could end up being a lot lower or higher depending on various of other factors as well.

4.1.2 Ecological

In a survey conducted by Müller and Voigt (2018), industries expected to gain resource and energy efficiencies as well as savings through the Industrial Internet, which would bring ecological and economical sustainability. However, new machines have to be manufactured in order for the transformation in companies' value chain to take effect. As transportation, processing and production of the raw materials are needed, it is also argued to have a negative impact on the environment. (Birkel et al. 2019: 11-12.)

Buildings are also a major factor on ecological effects, amounting a total of 40% for EU's energy consumption rates and 36% of green house gas emissions (Gilchrist 2016: 19). A European research project IoT6 set up a case study for multiple smart offices to research the potential of the Internet Protocol version 6 (IPv6) for IoT. Through a multiple different systems, a significant energy consumption reduction rates, as well as other benefits such as more flexible, secure and customizable building deployments were noticed with the solution compared to previous ones. (Ziegler & Crettaz 2014.) However, implementing proper control management systems for buildings, especially older ones, is not an easy task due to the initial costs and disruptions on business (Gilchrist 2016: 20-21).

There is also a risk and uncertainty on the effects, which the Industrial Internet might bring to actual energy consumption rates. Müller and Voigt (2018) discuss their findings, where the IIoT would boost resource savings potential such as energy savings and resource efficiencies. Those arguments are also supported by other studies, which include the benefits on transparency (Blunck & Werthmann 2017: 656-666; Beier et al. 2018: 8; Müller et al. 2018: 2-3). However, Birkel et al. (2019: 12) argue that the application of technologies will lead to a higher energy consumption rates, as the use of the digital networking will also rise. While the networking and automation leads to a better detection on failures, thus boosting resource efficiency, it could also imply for a higher energy usage (Stock et al. 2018: 265-266). The companies are also becoming more and more dependent on energy providers and as such, their prices as well. In a conducted interview, companies have also mentioned that following their digital transformation the energy costs have risen. (Birkel et al. 2019: 7, 12.)

Nevertheless, if the Industrial Internet is able to lower the energy consumption rates in the long run, greenhouse gas emission would also be reduced as data transparency allows for more informed analyses on environmental management processes (Beier et al. 2017: 232; Müller et al. 2018: 3-6; Beier et al. 2018: 2). As the industrial sector is one of the largest greenhouse gas emitters and air pollution contributors (Beier et al. 2017: 228), it makes improvements on those areas necessary. The impact is not only to the overall climate, but companies neglecting those areas could end up receiving serious economic repercussions from customers (Patala et al. 2016: 145). The younger generation is more and more interested and aware of the issues, as seen in climate strikes organized by youth all over the world (Climate Strike 2019). Even though the possible impacts would likely hit the most on companies providing consumer goods, B2B companies could end up using improvements on environmental issues as a marketing tool to provide goodwill amongst the customers. Goodwill has been demonstrated to have a positive impact on companies' performance (KPMG 2010: 11; Satt & Chetioui 2017: 109-114).

4.1.3 Social

The Industrial Internet could bring major social factors in place for various industries. It is also important to support and put effort on these matters, as the society is decreasingly tolerating companies that merely focus on economic benefits as opposed to considering the social and ecological aspects as well (Müller & Voigt 2018: 661). The current implications show that the social impacts of an IIoT could bring both benefits and challenges for human resources, as well as demands to the organizational transformation (Kiel, Müller, Arnold & Voigt 2017b: 14).

The major social impacts are anticipated in the health care industry, as well as in other industries that can provide additional safety measures for workers. The personal benefits provided by the IoT devices include enhanced scanning mechanisms and diagnostics, which help doctors to make more effective decisions (Evans & Annunziata 2012: 18; Greengard 2015: 148-150). Additional reminiscent tools can be provided such as a hand hygiene monitor, which could provide a major reduction on hospital acquired infections, as it is still one of the leading causes for hospital death's (Stock et al. 2018: 260). Medical health professionals are also able to adjust and tune the connected devices wirelessly without invading procedures, while monitoring the patient’s vital data (Gilchrist 2016: 14-15; Newman 2017).

As discussed in the introduction, several researchers have made arguments that the Industrial Internet would have either no connection or a negative connection on job creation (Bonekamp & Sure 2015; Beier et al. 2017: 232-233; Müller et al. 2018: 3; Müller & Voigt 2018: 664). There is also a growing amount of contradictory data from different instances. Reports from different business consultancies report a positive image of large amounts of new jobs being created (Gerbert, Lorenz, Rüßmann, Waldner, Justus, Engel & Harnisch 2015), while research institutes estimate a loss of jobs in general (Bowles 2014). It is to be anticipated that automation and technology will dispose a various of jobs focusing on simple tasks (Greengard 2015: 150-152). Yet, monitoring, training and collaboration jobs are still expected to be required in various industries (Müller & Voigt 2018: 661).

However, several of the jobs, including decision-making, can also be automated with the help of machine learning (ML) (Ford 2009: 228-229). The technology has also evolved enormously from that argument, supporting the claim even further. While that is not specifically tied to the Industrial Internet itself, it is able to significantly boost the ML process due to the sheer amount of data created by the IoT technology. Anticipations based on the combinations of various data and findings indicate a considerable decrease in lower skilled jobs, as well as an increased variety and importance in higher skilled jobs (Bowles 2014; Bonekamp & Sure 2015). As technology continues to evolve, shifts in job transitions will also become more natural. However, the amount of lower skilled jobs also make up a notably larger number than the higher skilled one's. (Ford 2009: 57-62.) In that sense, the job decreases from lower requirements would outweigh the increases in higher levels.

4.2 Possibilities

4.2.1 Strategy

Collin and Saarelainen (2016: 130) argue that the companies' internal benefits can be seen in three different categories:

- Improvement of sales
- Reduction of operations costs
- Reduction to the capital expenditure

The improvement of sales can be achieved with new products and services, as well as new BMs catering to potential new customer segments (Collin & Saarelainen 2016: 131-132; Kiel et al. 2017a: 9-11; Müller et al. 2018: 2-4). The operation costs can be reduced due to the enhanced productivity, predictive maintenance and optimization (Collin & Saarelainen 2016: 132-134; Schaeffer 2017: 37-40; Beier et al. 2018: 3-5). The reduction of capital expenditure can be achieved, as the companies’ investment patterns towards machines and equipment could be changed. The manufacturers can end up selling a machine service instead of the physical product, where the companies would pay by the machine’s real usage. (Collin & Saarelainen 2016: 130-134.)

Therefore, the Industrial Internet could completely reform the companies' current strategic operations. One of the key factors that arise through the Industrial Internet is the innovation and improvements to the existing and new BMs. Companies can find new innovative ways to enhance their current BMs to improve their value creation and competitiveness. (Müller et al. 2018: 4.) New innovative services are also able to be produced with the Industrial Internet that were not plausible before. Those can also provide more individualized solutions, which would improve the quality of the services. That would lead to better customer satisfaction rates and thus, potentially generating higher volumes of sales. (Kagermann et al. 2013: 22, 33.) However, changing and adapting new BMs is hard and could end up being detrimental to the company if not executed properly. While change is necessary to the general success, companies should not rush to change working and existing BMs with the digital transformation. Instead, ensuring to keep the current customers is vital and therefore, a preferable way would be to run new digital BMs in parallel with existing ones to gather important data on its nuances. (Gilchrist 2016: 237-239.)

Nevertheless, the new digital BMs would allow manufacturers to charge of their products use instead of selling the products themselves, which can revolutionize the way current services work (Gilchrist 2016: 10). The services could provide additional feedback and safety measures for customers, such as tracking of stolen objects and information about a more efficient use of a product (Greengard 2015: 60-67; Kotler et al. 2016: 148). While often hard to evaluate, customer experience enhancement tends to be one of the first areas, which is addressed with the digital transformation. Industrial Internet and Big Data analytics can provide more insight into customers' needs than ever before, which can provide vital information on companies' products and services. (Gilchrist 2016: 214-215, 234-235.)

A practical example of those method of services would be truck tires, where the purchaser would only pay for its mileage and usage per certain time period. This is made possible with the array of sensors that are being used in the tires. Through this method, a number of useful data could also be provided to the purchaser such as how the vehicle was used to inform of excessive speeds and events. With this type of service, a logistics company would not have to be purchasing new tires for every vehicle all the time with the risk of not knowing how long they would last. Instead, they mitigate the risk and hassle of new purchases and only pay for its real usage. While this is a good deal for the logistics company, it is also a good deal for the manufacturer as it increases the lifetime value of the product. (Gilchrist 2016: 10-11.)

4.2.2 Operations

The operational efficiency of companies can be improved tremendously with the IIoT technologies. The potential large advantages include cost reductions and optimizations through fuel- and energy savings (Evans & Annunziata 2012: 3-4; Kagermann et al. 2013: 25-27; Beier et al. 2018: 3-7), logistic improvements with increased process transparency (Hofmann & Rüsch 2017; Müller & Voigt 2018: 660-661; Beier et al. 2018: 6-7; Birkel et al. 2019: 4), productivity increases with more effective equipment (Evans & Annunziata 2012: 3-4; Kiel et al. 2017b: 9-11; Beier et al. 2018: 1-2) and higher production quality with more visible processes (Kagermann et al. 2013: 19-26; Schaeffer 2017: 39-40; Kiel et al. 2017b: 9-11; Müller & Voigt 2018: 661).

The operational benefits can now be applied more efficiently than before. As seen in Figure 9, the technology, which has already existed long before, can now be more cost efficiently implemented as the enabling prices of the technology have dropped tremendously. (Goldman Sachs 2014; Schaeffer 2017: 37-38.)

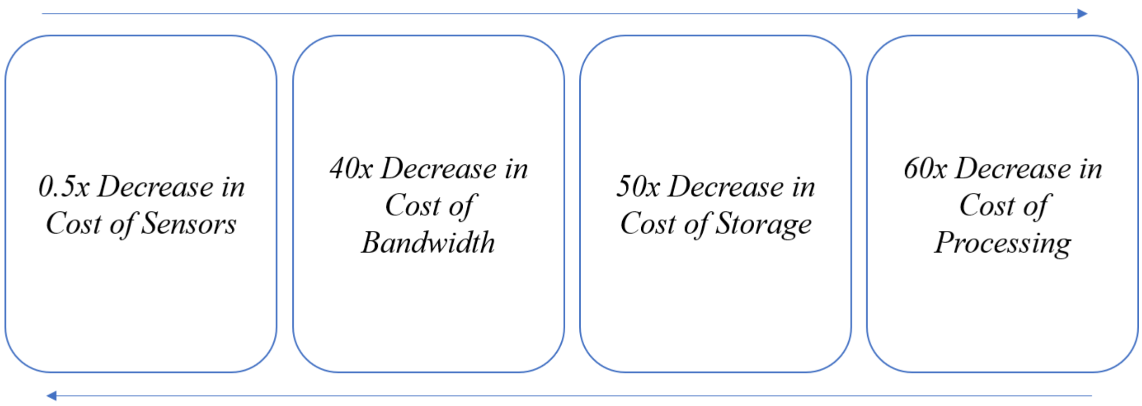

Figure 9. A Decade of Eroding Cost Fuels the Rise of the Internet of Things adapted from Schaeffer (2017: 38).

Collin and Saarelainen (2016: 61) addresses four major areas, where the Industrial Internet can be applied:

- Remote access, which allows remote monitoring, optimizing and updating
- Predictive maintenance and analytics

- New data-based service models
- Smart factory and autonomous products

The predictive maintenance has high expectations, as it could offer multiple potential benefits for the companies. The traditional time-based maintenance model has been often used in companies' machine maintenance, where in a certain time period a repair service is being made. (Collin & Saarelainen 2016: 73-75; Schaeffer 2017: 39-40.) The Industrial Internet, however, can transform this process, as the products and machines are remotely controlled and monitored. The incoming data can therefore be inferred if a maintenance service is actually needed. (Anderl 2014: 5-10; Collin & Saarelainen 2016: 73-75; Marques, Agostinho, Zacharewicz & Goncalves 2017: 302-308; Hunke, Yusuf, Rüßmann, Schmieg, Bhatia & Kalra 2017.) This allows the maintenance to be based on the machines real-time condition instead of a scheduled maintenance, resulting in cost reductions, enhanced machine use and thus, also improving production and machine life cycle (Collin & Saarelainen 2016: 75-77; Schaeffer 2017: 39-40; Hunke et al. 2017).

A practical example of a predictive maintenance are equipment parts such as an engine, where their parts status can be predicted when it is degrading. With this type of service, an equipment is monitored every second as it produces predictive data. By collecting all this data, a virtual copy of an engine can be produced and malfunctions can be found without touching the actual physical object. This concept, which is also known as the digital twin, is thought to have a large impact on reliability. Recommended actions can be tested this way with a virtual machine through Big Data analytics. (Gilchrist 2016: 11.) Moreover, a lot of today's production lines still continue to run on times, when no production is used. The Industrial Internet could provide more coordinated and automated machine power-ups, which would lead to improved energy efficiency usage. (Kagermann et al. 2013: 27.) The general digital transformation of operations is one of the key areas, where the Industrial Internet can provide immediate results (Gilchrist 2016: 235).

4.2.3 Environment and stakeholders

The Industrial Internet in a business activity implies to an entire communication network, which is able to exist between the different internal- and external stakeholders such as customers, companies, employees and suppliers (Maresova, Soukal, Svobodova, Hedvicakova, Javanmardi, Selamat & Krejcar 2018: 3). Previously, the company's relationship between the customer was limited to a product purchase and maintenance services. Through the rise of the digitalization and Industrial Internet, new services and information can be provided, which improves the customer involvement and therefore also strengthens the bond between the two. (Collin & Saarelainen 2016: 46-47.) Each section can also further optimize their adjustments in real-time depending on the status and demands of the network affiliates, which can provide all cooperative stakeholders in the value chain with shared benefits such as profits (Kagermann et al. 2013: 22; Maresova et al. 2018: 3).

Another major impact is in data transparency, which would allow different stakeholders to assess and analyze more transparent processes to make more cost-effective decisions. The majority of production employees are often not aware of various crucial information such as energy consumption rates of the machines. A more transparent process that could provide key information could be seen as a potential benefit and thus, end up reducing the overall energy costs. (Beier et al. 2018: 6-7.) While more data transparency has positive factors for companies to optimize their processes and services (Beier et al. 2017: 232; Müller et al. 2018: 2; Beier et al. 2018: 8), it also adds an increased amount of risk for cyber attacks and employee concerns (Kiel et al. 2017b: 14-16). However, a major sector that could benefit all the stakeholders is the potential logistics improvements. Data provides valuable information, whether it is traffic route adjustments, better tracking of goods, real-time updates or process optimizations that can significantly boost production rates, ordering and delivery times. (Hofmann & Rüsch 2017: 25-31).

Additional work safety benefits are also expected to rise in industries (Evans & Annunziata 2012: 17-30; Patala et al. 2016: 146; Müller et al. 2018: 6-8). With the

Industrial Internet, automated environmental- and personal monitoring can detect faults as well as environmental changes and as such, ensure good and safe working conditions (Greengard 2015: 60-72; Pilloni 2018: 5-6) and more socially acceptable workplaces through different assistance systems (Müller & Voigt 2018: 665). Although, it is crucial to have user-friendly solutions for workers, as complicated applications and processes often tend to be avoided (Kagermann et al. 2013: 50). In a factory setting, machine sensors can also detect human presence in a close distance and activate protective mechanisms to ensure safety (Thoben, Wiesner & Wuest 2017: 8-9). The improved safety would not only benefit the individual worker, but the company as well. As the employer is primarily responsible for any damages that is not intentionally inflicted by the employee (Hoppu & Hoppu 2016: 285-287), the safety costs would therefore be decreased as well.

As the future of jobs is changing, so are the workplaces and their environment. The tasks with the Industrial Internet will allow for more flexibility with digitalized connections, which includes more options for home office's (Herrmann, Schmidt, Kurle, Blume & Thiede 2014: 289; Müller et al. 2018: 6; Birkel et al. 2019: 4). This would promote the integration between the family and business, which could alleviate the workers stress and various other health issues. On the other hand, working at home could also be harder to find the balance between the work and home demands, resulting in breaks to avoid conflicts. (Araujo, Tureta & Araujo 2015.) However, as the abilities of the workers are still crucial to the success of the company, further training needs to be applied constantly (Herrmann et al. 2014: 289). Although technical innovations allow for vital learning of new systems and training environment improvements for employees' (Herrmann et al. 2014: 289-290), they also put more demands on them to continuously learn and get better (Birkel et al. 2019: 15).

4.3 Challenges

4.3.1 Cyber security, privacy and regulations

A variety of researchers and industry leaders view data security and legal issues as one of the largest challenges for the Industrial Internet (Perera et al. 2015: 33; Chike 2017: 4-18; Müller & Voigt 2018: 664.) and as such, further action and attention is needed for those areas. The size of the problem is a tremendous threat to both the companies and its customers. To give a better understanding of the magnitude of the issue, a small and medium-sized enterprise (SME) announced to have 500 to 600 cyber-attacks daily (Birkel et al. 2019: 16). PWC (2017) reported a 525 percent increase in industry-wide and medical device cyber security breaches. A large aviation domain business representative voiced the concern, that an outsider could cripple a production via remote access (Birkel et al. 2019: 16).

Companies in today's competitive markets are looking for ways to reduce the costs in order to price the products aggressively. As savings in material costs only go so far, since the competitors are also more than likely using similar ones, companies look into cutting development costs. Making reductions to those areas allows cost reductions without any noticeable effects on products actual functionality, but it also diminishes the quality and security. (Gilchrist 2017: 66-69.) The misconception, as Gilchrist (2017: 66-69) puts it, is that through personal experiences and different market researches, manufacturers have noticed a low willingness for customers to pay extra for security and privacy. The customers however do value those things, yet they should be given and not treated as an extra. In the IoT era, where collected user data will be larger than ever before, companies need to be able to gain the customers trust in order to succeed (Perera et al. 2015: 33). Therefore, in order to stay competitive, companies must develop systems to prevent data breaches (Thoben et al. 2017: 11). The risk of producing unsecure products can not only have a tremendous effect on the company, but the market sector as well. The negative publicity on one product can spread through the other companies’ products as well (Gilchrist 2017: 66-69.)

Building a proper end-to-end security into IoT devices is a challenging task for the companies, as they include many different technologies. When installing and implementing IoT devices, the companies should examine the security concerns extremely thoroughly, as it can be affected by both external and internal factors. Even if the closed enterprise network is relatively secured, the firm's employees may use personal IoT devices that knowingly or unknowingly connect and synchronize with the closed network and gain access through their work desktops. This can lead into huge data leaks. (Gilchrist 2017: 55-56.) The other threat is for the competitors to obtain valuable data through reverse engineering (Thoben et al. 2017: 12). Reverse engineering is often referred as a process, where the devices functionality is being emulated in order to see how it works (Aleksander 2005: 19-20). Therefore, massive stored datasets can potentially be captured by outsiders through multiple different ways. The major concern is that those could lead to valuable information being captured concerning trade secrets, properties and other highly classified knowledge (Bloom et al. 2018: 1). Preventing and protecting against personal devices has become a daunting task for the companies and has impacted the whole security protocols, as the potential threats can not only come from outside sources, but inside sources as well (Gilchrist 2017: 55-56).

Gilchrist (2017: 12-15) mentions the large scale of IoT products produced to the market and how they create huge security issues. As technologies advance, the products would also need to be updated accordingly. However, as new products come to market, the older one's updatability could end up being left in the dust. The other issue is how higher priced items such as cars faulty and old technologies could affect its resale value. Existing technologies are therefore not guaranteed to be able to provide a sufficient data privacy management lifecycle, which would help with the customers trust on IoT security. Moreover, regulations regarding data collection would also boost the consumers' confidence. (Perera et al. 2015: 38.) The industries should also try to move away from certifying the IoT devices as secure, as the ever-changing environment and the scope of the entire IoT itself is far too broad for any independent security standard to manage (Gilchrist 2017: 58-59).

The largest privacy concerns for the users are the lack of regulations in place and widely adopted norms regarding the standards of IoT security (Saleem, Hammoudeh, Raza, Adebisi & Ande 2018). There is also a lot of uncertainty towards data ownership, as even companies' legal teams are not aware of who owns the data in the first place (Birkel et al. 2019: 16). This can however change quickly in the future, when the technology becomes more and more available in everyday life. In the past few years, privacy concerns have received a significant amount of attention and are believed to have a large impact on the IoT's growth as a whole (Perera et al. 2015: 33; Chike 2017: 19-20). The changes in regulations can bring different governance issues in place, which could lead to various new legal issues for the companies (Chike 2017: 7-11). The new regulations can already be seen today, as the General Data Protection Regulation (GDPR) passed and came applicable in May 25^{th} of 2018 (European Commission 2018), which also affects the IoT devices and their networks. Due to the nature of the IoT, companies must spend resources to achieve data compliance, which in itself is a challenge in the context of an IoT. (Brar 2018.) Perera et al. (2015: 38) argues the necessity of strict laws and regulation to be implemented regarding data collection in order to have the consumers trust, where companies disobeying or misusing the information would be heavily sanctioned.

4.3.2 Competitiveness and future uncertainty

While in general the increased competition is seen as a good thing for a working market economy, individual companies may face tough challenges as the Industrial Internet draws existing and new Internet-driven competitors to disrupt the businesses (Ehret & Wirtz 2017: 111-113). Although, there is no consensus whether the competitive market environment actually has a positive or negative effect on the implementation of new technologies (Müller et al. 2018: 6-7). However, the competition between the companies lowers the general price levels of the market (Hoppu & Hoppu 2016: 441) and thus, could end up reducing the companies' potential overall profits gained by the Industrial Internet.

Nonetheless, with potential benefits the Industrial Internet also allows companies the opportunity to enhance their competitiveness by expanding the market share and strategic differentiation through innovative offerings (Kiel et al. 2017a: 8-11). However, as the adaptation of the technology has just started gaining enthusiasm in the recent years, the amount of organized research is still relatively low regarding the real benefits of the IIoT (Ehret & Wirtz 2017: 117, 125). Therefore, while the Industrial Internet allows for more opportunities, the risk of uncertainty should be taken highly into consideration.

Companies can also lose their competitive advantages quickly, as the entry barriers gets lowered. The Industry 4.0 shift will increase the pressure of prices, performance, costs and services, leading to customer's unwillingness to pay for non-IT related abilities. Other supply chain stakeholders will also be able to observe the data of key figures due to the increased transparency, leading that data to potentially be used against the company to negotiate more favorable prices. Important data could also be captured by competitors, which is not only a question about the protection of it, but the overall consciousness of which data actually belongs to whom. (Birkel et al. 2019: 11-18.)

The challenges for the companies is to keep up with the shifting markets, as latest technologies can dictate the overall movement of an industry. Following the wrong standards or missing the current trends of an Industrial Internet is seen as a major challenging factor. (Kiel et al. 2017b: 11-15.) Companies should aim to individualize their products to the demands of customers to maintain and improve their current competitive position, as the IIoT will allow for more individual customization with the gathered data (Ehret & Wirtz 2017: 120-121; Müller & Voigt 2018: 663, 666). In that way, companies could end up on the better side of the competition.

4.3.3 Adaptability, employee qualifications and acceptance

Several researchers (Kagermann et al. 2013: 53-54; Kiel et al. 2017b: 14-17; Bonekamp & Sure 2015; Birkel et al. 2019: 21) argue that the companies' adaptability, as well as the employees' qualifications and acceptance towards the Industrial Internet has been seen as a challenge. However, Müller et al. (2018: 11) evaluation of a study showed a positive influence on employees' qualifications and acceptance. Although the result could be questioned, as the limitations of the study were recognized, thus not necessarily representing the target group accurately (Müller et al. 2018: 15).

The adaptability of the Industrial Internet to the company can be a challenging task to achieve, as it requires a transformation of various organizational processes (Kiel et al. 2017b: 14-20; Müller et al. 2018: 3-5; Birkel et al. 2019: 1). The digitalization of the processes itself is a vital task for today's companies to succeed and will require new competent workers to be hired, which can also be a hard task (Birkel et al. 2019: 8). Although new working opportunities and environments can arise, greater demands will also be placed on employees' skill levels (Kagermann et al. 2013: 53; Müller et al. 2018: 3-6). This can add further reluctance for existing workers, as some will be at risk of job losses and others will need further specialized training, resulting in additional costs and risks (Müller et al. 2018: 5-8; Birkel et al. 2019: 8-14). As such, it is crucial to offer essential awareness and training for employees to help them prepare and understand the needed requirements (Kagermann et al. 2013: 51-54; Kiel et al. 2017a: 15; Thoben et al. 2017: 5-6). A clear strategy towards employee qualifications is therefore a necessity to achieve a generalized acceptance amongst workers (Birkel et al. 2019: 13-14).

The implementation of the Industrial Internet will also lead to a growing amount of incoming data, which is harder to manage. As more and more manufacturing systems are connected to the network, it will be difficult to collect and analyze all the necessary data. (Bloom et al. 2018: 9.) This requires companies to build, develop and modify new systems and software to handle the data and improve Big Data analytics, thus increasing the costs (Thoben et al. 2017: 6-13). Managing the technologies also adds an increasing amount of complexity (Ehret & Wirtz 2017: 113). Other IT risks are also growing such as the requirements of stable networks and servers to function properly (Birkel et al. 2019: 16), thus making it necessary to be able to adapt constantly to the changing environments (Kiel et al. 2017b: 17-20; Thoben et al. 2017: 12).

5 METHODOLOGY

Methodology is *"the way in which we approach problems and seek answers"* (Taylor 2016). This chapter describes the methods, approaches and designs of the study and the reasons for choosing those specific ones.

5.1 Research approach and method

This study could be executed with two different research approaches, which are most commonly associated with inductive and deductive approach. The approaches describe a process, where in a deduction the theory-based hypotheses are the basis of the observations, whereas in an induction the connection is reversed between the observations and theory. In other words, the approaches describe the process where the research begins. (Bryman & Bell 2011: 11-14.) While the original plan was a deduction approach for the study, over time it became more clear that an induction approach would suit this study more appropriately, as theory regarding the Industrial Internet and its sustainable value creation is rather shallow. Therefore, certain gaps in existing theory could be improved and filled. Given the novelty of the subject, generating new theory from observations cannot be ruled out, which could have also caused some overlap between the inductive and deductive approaches. Yet, we should not get caught on the specific distinctions between the approaches, as there is no reason why certain overlapping should not exist (Wilson 2014: 13-14).

The strategies of the research are often described as quantitative and qualitative methods, as well as a combination of both, referring to a mixed method (Creswell 2014: 3). Quantitative methodology describes a research that is based on the amount such as in numerical or percentage terms (Krishnaswami & Satyaprasad 2010: 5-7). Creswell (2014: 4) refers it as *"an approach for testing objective theories by examining the relationship among variables"*. The goal is to produce direct data, which can be used to draw statistical analysis. The main approach for data collection is from the masses through surveys or by monitoring the respondents. (Krishnaswami & Satyaprasad 2010:

5-7.) Whereas, a qualitative methodology describes the spoken or written language of the people and their behavior (Taylor 2016). Creswell (2014: 4) refers this type of method as *"an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem"*. The goal is to generate descriptive data to understand certain patterns, insights and concepts (Taylor 2016). The approach to data collection is through the respondent's in-depth interviews and discussions (Krishnaswami & Satyaprasad 2010: 7-8). A mixed method describes a combination of both quantitative and qualitative data collection methods, which involves the integrations of those forms (Creswell 2014: 4-5).

The main difference in the quantitative method of respondent monitoring and the qualitative method of the in-depth interviews are the setting the research takes place. While monitoring is conducted in natural field conditions, the interviews are specifically arranged to suit the situation of the research. (Taylor 2016.) Quantitative method is also often associated as a deductive approach and the qualitative as an inductive approach, although their tendencies and distinctions are not as straightforward such as theory being used as a background in qualitative studies (Bryman & Bell 2011: 13).

A qualitative research method was chosen for this study for several reasons. Firstly, the effects of the Industrial Internet from sustainable value creation point-of-view is seen as a novelty in the research field. While gaining popularity in the recent years, more insights could be gathered by in-depth interviews, as the theoretical groundwork is still rather weak. Secondly, quantifying the effects of the Industrial Internet in numerical terms is a challenge and could therefore provide unreliable data without the interviewees' providing proper context. Thirdly, due to the nature of the topic, it is crucial to interview top personnel as of their knowledge regarding the individual company and its digital solutions, operations and strategy. Therefore, creating accurate data from quantitative approach could produce a challenge in terms of accessing the number of those individuals.

5.2 Research design

A research design is a framework into succeeding in a research process (Wilson 2014: 116-117). It may include designs ranging from action research, case study, experimental, cross-sectional, comparative and others. Choosing the specific design depends on the nature of the study, research questions and the overall approach of the research. (Wilson 2014: 120.)

A case study design was seen appropriate for this study, as the effect of the Industrial Internet phenomenon in sustainable value creation of companies is the main research question to investigate in this study. A case study examines a phenomenon in a real-life context, where the relationships between the two are not distinct clearly, providing an analysis for the problem itself. Case studies can be divided into single and multiple cases, describing the scopes of the designs, as seen in Figure 10. (Wilson 2014: 121-123.)

	Narrow	Broad
Narrow	Single case designs (holistic analysis)	Multiple case designs (holistic analysis)
Broad	Single case designs (embedded analysis)	Multiple case designs (embedded analysis)

Figure 10. The scopes of case designs adapted from Wilson (2014: 121).

The research design type of this study is an embedded multiple case study as it includes different industrial companies, therefore multiple units to be analyzed. A multiple case study was selected instead of a single case study, as it provides a deeper insight into various organizations and their solutions. This would provide more context and perspectives into understanding the phenomenon and allow the comparison between the companies to arise as a research question. A multiple case study describes an in-depth method, where an analysis is made between the individual companies' in relation to the environment itself. A part of the research step is shaping hypotheses, where comparisons are made between the gathered data and existing theory. (Järvinen 2012: 77-81.) However, in a qualitative case study research, inventing hypotheses is also often a necessity to interpret the different sources of information (Alasuutari 2011). As one of the goals of this research is to describe the phenomenon and compare its existing studies in relation to different companies, the method fits that category well. Multiple cases are like multiple experiments, where the more cases to establish or revoke a theory, the stronger the outcomes and arguments of the research are (Wilson 2014: 122). For this study, five different companies was seen as an appropriate number to establish possible patterns and deviances. Having a lower amount of cases would have caused the observations to be less reliable and as a result, the outcomes would be weaker.

5.3 Data collection and analysis

For the data gathering method, a various of techniques could be chosen such as interviews, surveys or observations. The interview method was chosen, as the participants could provide unique information and perspectives for the study. As the interview technique was chosen for this study, an unstructured, semi-structured or structured interview approach could be chosen. In an unstructured interview the questions are open-ended and may provide richer and newer information, whereas a structured interview questions are predetermined and could produce more generalized and consistent data. However, while in a structured setting the responses are very limited, an unstructured setting can generate a large amount of irrelevant data. (O'Gorman & MacIntosh 2015: 118-120.)

A semi-structured interview method is described as an unscripted interview, where some questions are prepared beforehand, but depending on the interviewee some improvisation is also used (Myers & Newman 2007: 4). In this research, a semi-structured interview was seen appropriate as the companies’ situations may vary a lot, leaving also room for more detailed follow-up questions. For example, the IoT strategies and implementations may be vastly different, which leads the conversation into a different direction. More valuable data could therefore be gathered, as the respondents are also highly skilled professionals in their fields.

A contact list for the potential interviewees was gathered through previous work contacts. An invitation with details describing the master's thesis was then sent to all of the contacts. Furthermore, the negotiated access to those specific companies were selected from the individuals, who accepted the meeting invitation. The interviews took place between April and May. Table 2 describes the details of the interviewees and their companies.

Table 2. Description of case interviews.

Company	Title	Interview time and date	Sector	Employees
Company A	Chief Digital Officer	Date: 16.4.2019 Time: 1:01:49	Manufacture of lifting and handling equipment	10 000 - 20 000
Company B	PLM Manager	Date: 14.5.2019 Time: 0:59:24	Manufacture of instruments and appliances for measuring, testing and navigation	> 5000
Company C	Chief Technology Officer	Date: 21.5.2019 Time: 0:52:32	Wireless telecommunications activities	20 000 - 30 000
Company D	Vice President Strategy and Business Development	Date: 22.5.2019 Time: 1:04:24	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	10 000 - 20 000
Company E	Research Director	Date: 24.5.2019 Time: 0:37:54	Activities of head offices	10 000 - 20 000

All the data was anonymized due to the interviewees request's, describing only the necessary information regarding the interviewees title, industry sector, the company's range of employees and the time and date of the interview. Three of the interviews were organized face-to-face meetings and two of them were structured via the Internet. An hour was scheduled for the interview process with each participant and the same question base was also used in every situation. The spoken language was Finnish in four of the cases and English in one. All of the interviewees gave an acceptance to record the conversation. The recorded audio was fully transcribed for a more detailed data analysis, amounting the total gathered data to over 70 pages. Transcribing the English interview was significantly more time consuming, as certain words were more difficult to distinguish from each other. The gathered data was coded into themes and phrases, which were the most relevant to the research.

As the data of a qualitative research is examined as a whole, statistical odds charts are not sufficient to draw any conclusions. Therefore, a common opinion cannot be reformed if one data case differs from the rest, as the number of interviewees is not large enough to make that conclusion. Instead, an analytical two-step process is made, which consists of summarizing the essential observed data from theory-bound view and interpreting the results through that data. (Alasuutari 2011.) A theory-bound data analysis method is a hybrid method between a full content analysis and a theory-based analysis. Therefore, the analysis of the data is not fully based on theory, but the connections are easily observable from that. (Saaranen-Kauppinen & Puusniekka 2006.) Theory-bound data analysis method was seen appropriate, as it allows the existing theory to be the basis of the analysis, but also leaves new information to be discovered within the gathered data due to the novelty of the subject.

5.4 Data reliability and validity

Reliability describes the consistency and repeatability of the results. In other words, the same results should be achieved if the study would be repeated under the same conditions. (Bryman & Bell 2011: 157-158; Wilson 2014: 129.) In the context of this study, the participants were selected for their knowledge and suitability of the subject. Most of the interviews were negotiated months before the interviews took place, while the actual scheduling was left for a later date. Since the interviewees are top personnel of their respective companies, the suitable time and setting was proposed by them. In the interview setting, the interviewer had to keep a constant eye on the clock and the flow of the interview on which points had been talked about and which were not. However, in two of the cases, the scheduled one hour was not enough time to ask all the base interview questions. In those cases, the interviewer had to improvise on what questions to ask with the remaining time. As it turned out, it was the points that had not been talked about yet. Similarly, more follow-up questions was asked with the participants that were also able to answer all the base questions in time. Two of the participants also approached the subject from a more technical perspective due to their background, resulting in certain differences in points-of-view. The participants respective companies are also in different stages of the implementations of IIoT solutions. Therefore, the overall replication of the results can vary on multiple different levels depending on the interviewee, its personality, background and respective company.

Reliability also needs to be combined with validity to have reliable results. Validity refers to measuring the things that are supposed to be measured. (Bryman & Bell 2011: 157-165; Wilson 2014: 129-136.) Wilson (2014: 132-134) separates them into internal and external validity, dividing the internal types into content- and construct validity and the external types into face- and sampling validity. While Bryman and Bell (2011: 159-160) also includes ecological validity, establishing validities as face-, concurrent-, predictive-, construct- and convergent validity. In the context of the thesis, internal validity raises the concern on the measured impact of an Industrial Internet. Can we be sure, that the supposed impacts in companies are due to the Industrial Internet and not the combination of other factors as well? Independent variables need to be taken highly into consideration to identify the specific factors, as the topic is new and the measurements have not been fully understood yet. External validity tackles the issue on whether the results can be generalized (Bryman & Bell 2011: 43). While the companies and their solutions may differ, certain results can be generalized when similarities are seen. However, the generalized approach only applies in a more general context. A more individual approach is in this case more applicable due to the novelty of the subject and the overall knowledge of the participants.

6 EMPIRICAL OBSERVATIONS

This chapter briefly describes the case companies and presents the interview results in main themes, which were analyzed from the gathered material. The themes describe the key factors that came up from the material and are relevant to the study and its research questions. As the qualitative and descriptive nature of the research and topic, as well as the valuable experience by the interviewees, the findings are represented with multiple quotes to enrich the observations.

6.1 Case companies

Company A is a world-leading firm in its industry, which can serve a wide variety of customer segments including manufacturing, process industries, terminals, shipyards and ports. The company has a long history in providing lifting solutions and lifting equipment services for customers. The group has between 10 000 - 20 000 employees in 50 countries and its total revenue was over €3 billion in 2018. The interview was conducted with the company's Chief Digital Officer, who is an experienced and knowledgeable expert regarding the subject, as the interviewee has worked his whole career in various digitalization tasks including the Industrial Internet.

Company B develops and manufactures sports and outdoor equipment, software's and technologies, which serve fitness customer segments by offering a variety of products alongside the needed advice and support. The company's revenue was around €180 million in 2017 and it employs between 1000 - 5000 people globally. The interview was conducted with the company's PLM manager, who specializes in the products lifecycle management. The interviewee is knowledgeable about the subject, as they gather a lot of data from IoT devices.

Company C provides telecommunication services and network access to customers globally. The company's revenue was over €8 billion in 2018 and it employs between 20 000 - 30 000 people globally. The interview was conducted with the company's Chief

Technology Officer, who works in the group's subsidiary operations. The interviewee is also one of the leading experts on Industrial Internet in Finland due to being involved in national research projects regarding the subject.

Company D is a worldwide leader in smart technologies and lifecycle solutions for energy- and marine markets, serving multiple customer segments. The company has between 10 000 - 20 000 employees in more than 80 countries with total revenue of over €5 billion in 2018. The interview was conducted with the company's maritime business sector's Vice President of strategy and business development, who is a knowledgeable expert regarding the subject due to working with multiple IoT solutions.

Company E is a world-leading developer and supplier of technologies, services and automation for various sectors such as energy and paper industries. The company employs between 10 000 - 20 000 people around the world and its total revenue was over €3 billion in 2018. The interview was conducted with the company's Research Director, who works in various of hands-on tasks with the IIoT solutions regarding cloud and AI. The interviewee is a knowledgeable expert on the executions of the technical side of the Industrial Internet.

6.2 State of the Industrial Internet

6.2.1 The utilization to products and services

The companies view the Industrial Internet as a possible enhancement to the current and new products and services, as well as providing an opportunity to allow new digital business to be formed. Furthermore, as all the companies have already implemented the Industrial Internet into their business processes, they have managed to either improve or create new services through that. Company D describes that *"IoT is an enabler for better service levels."*, thus giving an opportunity for the companies to increase the satisfaction of their customers. However, it is very important to distinct the two.

Industrial Internet allows for better and enhanced products and services to arise through the technology. The Industrial Internet is not the product or service itself.

“We are not selling an IoT service…we are using IoT to augment the quality and service level of our products, or we are augmenting the performance of a product.” Company D

"...it is the new service that you start to build and not the Industrial Internet. The Industrial Internet is only there like an enabling technology." Company C

While the main concept of collecting data from products has been in place for years, since the 1990s as pointed out by some of the companies. The main difference compared to the recent years has been the cloud services, analytics and price decrease, which has made adopting the solutions much more cost-effectively. Company A mentions how years ago, it might have cost a million to connect the first device and get data from it, while nowadays it could be done within hundreds. Further referring that entry barriers are low nowadays, as companies can scale the costs per usage, resulting in an enormous connectivity growth on smaller products, which essentially has started the new wave called Industrial Internet and IoT. Yet, company A also points out that the problems are not new in the sense that for years there has been clear things, where it has been utilized while constantly trying to get to the next level.

"In this space there aren't many things, where technical solutions wouldn't exist, or could be developed fast and cost-effectively. The challenge is, what problem are we actually trying to solve." Company A

Two of the companies describe how the Industrial Internet has increased the general understanding of the assets, products and services. Furthermore, company B expresses the large change compared to previously to be the ability to see very precisely, where and how their product is used in an authentic environment, which then tells very important things from a business point of view. Similarly, company D describes the ability to measure more with the IoT to be a key factor.

"...what IoT as an element brings into the Industry 4.0, brings the ability to start measuring more, at cheaper cost on top of with what we have to measure because of the regulation." Company D

Being able to understand the products and services better has also allowed to monitor them more efficiently. Bringing the capability for improvements and to react faster to possible problems should essentially lengthen the product's lifecycle as well. Company A describes that the Industrial Internet allows new services to be brought to the interface to help the user during the lifecycle. Moreover, company A expresses how the Industrial Internet and digitalization in general has brought the ability to constantly bring something new to products and services by doing it cost-effectively remotely and through system updates. Company B also describes how software updates can be provided through services, while constantly seeing how the devices are working in case of any problems that need to be addressed. Similarly, company B refers how during the early phases of a lifecycle more can be taken into consideration.

6.2.2 Legislation

All the companies have had various of data regulations come into play with the Industrial Internet. Some of the regulations are industry specific, while others are country specific. Company E mentions a specific case in Australia, where the data had to be stored regionally, while company C expresses specific strict industry regulations on where data can be utilized and how it has to be anonymized, so you cannot tie it to a specific customer. While the regulations are in some aspect’s a slowing force, as more things need to be taken into consideration, company D views it in a different light:

"I actually could say that it provides an opportunity, because regulation provides framework of reference, and framework of reference brings things together." Company D

Referring to the fact, that while regulations are often viewed as a negative in consumer space, but in industrial space when developed together *"they can actually support the development"*.

The privacy aspects of the Industrial Internet are due to handling personal data, as there are not many regulations regarding machine-generated data. While company E has not had any privacy issues as they collect machine-based data, the other companies mention GDPR and its impact on their personal data management:

"Firstly, it was an enormous workload to implement it and then ensure that we can operate under those boundaries." Company B

"…on the other hand, we would want to personalize the devices the best way possible for the user...but then we come into the handling of personal data, others and legislation on how they have to be handled." Company A

"As soon as we start handling customer-based data, then the GDPR type of things come into the table." Company C

"GDPR has brought to the attention and has actually enforced the importance of personal data management, the next step is to get some level of guideline." Company D

Another aspect that has not been sorted out is data ownership, as there are no clear legislations on it. While all the companies mention some obscurity in certain data ownership situations, they had a various of different responses regarding typical company scenarios. Company D mentions a principle, where they ask the customer for a permission to use the data. While there needs to be an agreement on who will own the results of the analyses, they also understand that a customer may also want to retain the ownership of the data. However, when certain vague situations occur, it gets more interesting. Company D refers to a scenario in shipping, where a company would lease a vessel with a time charter and someone else would operate it with the charter, while also having the original ship owner, manager and so forth.

“Who owns the data in that kind of scenario, these kinds of things have not been sorted out in my opinion, but is that really a problem…” Company D

Company E describes a client case regarding to provide a data exploration, where the customer had made an internal decision to have all the data stored only in their cloud service, preventing the company then to giving the customer their proven algorithms in case of replicating them. Yet, that is more of an architectural problem to the data ownership question. Company B mentions one challenge regarding a service, where customers can upload their own data. Adding that they need to ensure, that the data does not leak from their end, but to a data ownership question, comparing it to *"if you leave a wallet with doors open to the side of a car windshield, it is not the manufacturers fault if that is then stolen.”* In other words, if a person chooses to upload their personal data to an open platform, it is not the responsibility of a company that tracks that data, but the person who uploads it.

However, company A assesses a more relevant question to be who has access to the data. Then further explaining it by pointing out a digital service or a platform business solution, where *“for providing a service, it could be more important to know what data you have access to, what price, who might be interested in the data and in which terms.”*

In the end, data ownership also ties directly privacy and cyber security aspects with Industrial Internet. While it raises some questions in certain situations, the overall impression from the companies was that it is not seen as much of a problem. The more fundamental aspect of it is, who can view it and has access to it, as in reality that is what ultimately matters. However, a distinct legislation on data ownership could bring more clarity to the question, thus also allowing a better understanding for more specific situations.

6.2.3 Cyber security

Cyber security is viewed as a challenge with three of the companies, but not something that would prevent the development:

"You have to always think about the security view of the data. That is one retardant factor but it's not a barrier in a way." Company C

"Cyber security is clearly a challenge for the industry and that's something that we're investing heavily on...it's also an opportunity for the industry in terms of services, in terms of new regulations coming to play." Company D

Company A refers that when developing and specifying new products, it is impossible to know what kind of services, cyber security demands, customer needs and company needs are required in five years. More focus should be on the fact, that specific architectures would be built in order to add certain cyber security updates and features remotely and cost-effectively. Adding, that the most critical factors in combating those challenges are systematic dealing with cyber security threats and be up-to date on legal demands, such as dealing with the customer information. Those are the areas that should be handled right from the start. Company C mentions letting the data being utilized, but as certain data could be extremely sensitive, allowing anyone to control it remotely could cause serious problems with production and quality. Cyber security is also seen as a continuous investment by the company D, not something that can be ultimately achieved.

However, companies B and E did not express cyber security to be any kind of a challenge. Yet, they also have a more hands-on background and approach on data handling compared to the representatives of other companies, which saw cyber security as a clear challenge. Company E puts it as *"AWS solutions are good"* in terms of dealing with cyber security threats, referring to the Amazon Web Services cloud computing platform. Moreover, company B did not mention cyber security when asked a follow-up question on whether dealing with cyber security threats, regulations or privacy had caused any challenges. This begs the question on whether cyber security actually is as large of a challenge as thought regarding the data produced by the IoT solutions? Yet, that ultimately depends from which perspective to approach it. It may be a relatively minor issue for the personnel handling the data while storing it through cloud computing services, as the responsibility is then shared with the company itself. However, the responsibility of the company is then to choose the right and trustworthy service provider, choose which data is visible to whom and keep things secure on their end as well. Company D mentions cyber security behavior such as a person plugging USB-stick into control system without too much thinking that it may contain a virus, or more generally sophisticated security attacks. In other words, while the produced data might be relatively secure in a cloud computing platform, attackers can still find ways to affect the overall data collection process at the company IT system.

6.3 The sustainable solutions of the companies

6.3.1 Sustainable mindset

The overall impression from all the companies was that they view sustainability as an important factor in today's business. While the definitions varied in their approach, the general consensus was similar regarding the ecologic aspects, but varying a little on social factors. The economic factors were not described, but they often correlate with the ecologic factors, as pointed out by several of the companies. Furthermore, two of the companies also highlighted sustainable measures to be profitable for the company in the long run.

“I believe more and more capital will be allocated to the companies, that are sustainable and are part of the solution to solve the global issues.” Company A

"...there is a possibility to have profitable sustainability, which is actually...an important point to discuss." Company D

Moreover, company A also points out sustainability as a principle, with which is a lot of evidence being beneficial in business activity. In addition, more talks should be made on what and how the company’s direct or indirect contributions will help in the global issues such as the climate change. Referring that the only way to do good business in the future from the owner’s point of view is to also tackle into these issues. And in reverse, investors and good employees will be shying away from companies that are not sustainable and do not have a meaning.

6.3.2 Monitoring

Monitoring allows the companies to see information in real-time. Company C expresses monitoring capability as the first overall step in the implementation of the Industrial Internet, which then allows the next steps to be taken. Those includes controlling the devices and then optimizing their usage, also referring to an article by Porter and Heppelmann (2014), which fourth step is autonomy.

The companies mention a various of ways, where the monitoring systems can provide better efficiency. All of them can provide some type of condition-based monitoring system. Therefore, the conditions of the equipment can be seen in real-time with remote systems. Furthermore, three of the companies express how it has reduced the need to travel between different locations as the information is already available, reducing the greenhouse gas emissions as well as the costs associated with it.

"Useless site visits...we have a better visibility there and can make decision in real-time on when to go there, that has had a clear impact..." Company C

Understanding the operating conditions of machines has allowed the companies take preventive maintenance measurements to take place. While in theory it is often described as a predictive maintenance, company A refers it in these types of industries to a more of a dynamic maintenance. The maintenance program is more likely to adapt to a certain measurement, such as usage- or load- metrics, where maintenance is executed when needed. Adding that the situations, where you can predict the time of breakdown of certain components is a lot less common in industries. The condition-based monitoring also varies with the companies asset's; hence industries can expect different outcomes. Company D mentions adding more sensors to understand the machine conditions better, which leads to preventing possible failures or defects, while company C mentions a better visibility and real-time decision-making on networking sites. Therefore, as almost all of company C's maintenances have been outsourced, it has clearly reduced the amount of work required by them.

Monitoring is also heavily tied into the traceability aspect of the Industrial Internet. Company C mentions a traceability aspect, where deliveries can be tracked in real-time, allowing then that data to be utilized in their customer service. Company B also describes a traceability of order- and supply chain, starting from raw-materials to the end to be easily transferrable to monetary value. Adding that when components fail, it can be easily traced back to the original source. In a scenario, where even if a recall would occur, they would still be able to pin-point very accurately to where the defected material was.

Regarding the sustainable economic impacts after the implementation of the Industrial Internet, company A refers the measurable economic factors to be evaluated case by case. Then further explaining that when previously the monitoring would be done by a person physically checking and measuring the values and implementing the results to a software, nowadays you could have assets to create values automatically. The measurable value could then be measured by a case specific situation, where you can calculate how much the operation cost was previously compared to today, and how much more cost-effectively it was done.

Furthermore, company B describes how a large part of their services is for the customers to upload their data to provide feedback analysis on their exercises, recovery and sleep monitoring. Moreover, that data can be monitored within a team to set an equal training ground for all the individuals regardless of their personal level. The monitoring has also allowed a trainer to see incipient symptoms from the data before the person would even recognize that. While those solutions clearly have impacted the social factors of the users, it is unclear whether those solutions have created any economic value for the company. When asked, if the better service has been visible on the amount of created value, company B could not provide an answer, but assesses *"if there was no service, then what would be the situation"*. Essentially, it is hard to quantify how much value would be lost, if the company would not provide those kinds of services.

6.3.3 Optimizations

All the companies mention electricity optimizations, which allows the energy usage to be reduced, therefore lowering the overall electricity bill and greenhouse gas emissions. While the participants could not provide any data on how large impact, if any, it had made, company C refers this as: *"If we wouldn't have made those operations, our electricity consumption would have risen further."* Although, it can be hard to express how much value it creates, as the addition of the IIoT solutions could also be expected to raise the energy usage.

Three of the companies also mention fuel consumption optimizations either internally or by providing them to customers. However, this is one of the areas where the industries vary, as the amount of assets can be different. Therefore, companies that do not have assets that consume fuel are unable to perform optimizations into that area. Company D mentions impacting fuel consumption by providing trimming, but adds that *"you can do more, so far the technologies have been developed so that they impact the system where they are applied."*, adding that you can even optimize the communications of the logistics chain to reduce costs. Company A mentions more-effective energy usage on how the products are used and their optimization, whether it is with hybrid or electric solutions that can reduce fuel consumption and improve the utilization rates. Even with the products that use combustion engines, usage optimizations can be made to reduce the idle rates. Company A concludes it as: *"Energy efficiency is a no-brainer everywhere, as it is a competitive advantage for us, brings economic benefits to a customer and is sensible for the environment."*

Four of the companies also describe the use of a digital twin, which allows for a 3D-model of various views. Company D mentions, how IoT has allowed the measurement of processes in different ways:

"We are for instance using IoT to optimize the flow, the workflows of the processes within a factory and we see already benefits of it" Company D

Further explaining that optimizing the processes within a factory by being able to see how things are moving through a created 3D-model and making decisions based on that to make it more efficient. That way the whole manufacturing process can be optimized.

In addition to various areas where optimizations can be utilized, company E mentions optimizing the flow of raw materials to be an important part of their services, as it extends the lifecycle of plants. Moreover, company E is also the only company to express break off analytics in their data analytics services, which is an interface where the operator can see the root causes of the breaks. That allows then the predictive measurements to take place, which has brought significant economic, as well as ecologic value through less discarded production to their customers. It is executed in a process, where a data explore is done to the customers machines to test the basic model's break off sensitivity on whether it is modellable. If it is, an installation of their template can be transferred to customers, as they have worked on template solutions for different machines. Company E describes a concrete example of the measured benefits of this in a paper production case, where a single machine would produce one roll in an hour with a selling price of 50 000€. Their provided break off analytics can reduce the customers amount of breakage by an average of one per week, as the machines tend to cut-off certain amount of times. While all of the breaks cannot be prevented, this allows for over €2 million of cost reductions per year for the customer's single machine. The results are also replicable, hence the more machines the larger the benefits.

6.3.4 Safety and work

When asked if the Industrial Internet had brought any social factors, three of the companies describe that they can provide, or are in the process of providing IIoT solutions that can improve safety.

"Many of solutions we're developing have an impact on safety." Company D

"On smart systems we can improve, like reduce the risks on how they are used and all the security checks and others..." Company A

Moreover, companies A and D further express the importance on safety. Company A describes it as *"...safety is one of the key things in our products to get them as safe as possible to the users..."*, while company D expresses the general importance of safety as *"safety means culture".*

Company A mentions how their larger products can be controlled anywhere remotely, allowing the user to move into more comfortable and safer working environment. Adding that when the products are semiautomatic, it also allows the efficiency to improve tremendously, as one operator can control more than one device at a time. Company E mentions how they are prototyping solutions, where the workers pulse and activity levels can be monitored in dangerous conditions and temperature levels. It also allows to trace the workers in case of an evacuation or an emergency, resulting in an insight to see whether someone needs to be rescued. However, the company is still researching whether those kinds of solutions are worth to be productized.

Regarding whether the Industrial Internet has had an effect on jobs, four of the companies clearly see that different types of competencies are needed. Moreover, two of the companies express that the Industrial Internet has had a large positive impact on the amount of work:

"Absolutely it has created jobs, as we have started to develop services through that, and we see that as a growing business" Company C

"Extreme amounts of jobs and interesting, challenging jobs, and see that there is work for terribly large group" Company E

While company A could not estimate the net effects, the overall impression was that it creates a lot of new jobs, which were not available before. However, at the same time it may reduce in some parts, move them into a different value chain or hire subcontractors to do the work that was previously done within the company. Furthermore, company C also expressed that it may have reduced the work on subcontractors. Company D describes new outside competency needs, but also training to the existing and new employees.

"We are actually training people that have a long experience in our industry, so they understand any opportunities that the IoT brings to the picture." Company D

6.4 Creating value from data

6.4.1 Quality of the data

One of the things that arouse through the interviews was the importance on the quality of the data. Moreover, two of the companies mention data quality as a crucial factor, when performing data analysis.

"The data, its quality and processes, how it is collected and handled, are key things as enablers, that allow new digital business to be formed." Company A

"The reliability of transferring information and the quality of the data is pivotal." Company E

Company D expresses *“it’s not just data, it’s the interpretation of data that really matters."*, referring that the amount of data does not matter if you do not have the expertise to utilize it properly. Furthermore, four of the companies describe the major factor in creating new value is the capability of analyzing the data to get proper information. Moreover, two of the companies also highlighted the fact that the data itself does not do anything; it is what you do with it. In order to even create value from the data, it needs to be refined and analyzed. While it is difficult to assess and compare the data analytics of the companies, company B describes the large challenge in general to be in *"how to get that data refined and dig the essential out"*. As the amount of data keeps growing, analyzing and utilizing all that data is still in the early steps.

Company C refers the essential form of creating value with the Industrial Internet to start with being able to refine the information through data analytics and machine learning into a sensible information that can then be utilized in processes. That will allow to integrate it as part of the operations and essentially also being able to later productize it as a sellable service through an application to the customers. Essentially, companies are selling the knowledge, expertise, models and algorithms that can refine the data they are getting into a valuable information.

While the companies themselves might be able to gather qualitative data from their own products, it can be hard to get that from all the other Big Data sources as well. Company A indicates, how a key challenge with the company is the quality of the available data. Adding that the products lifecycles are long and there are a lot of products that have been received through company acquisitions, that have not been designed for the specific usage. Certain products have been developed with different systems and are delivered all around the world from different factories, meaning collecting uniform and qualitative data in order to perform meaningful analytics is extremely difficult in-reality. A large part of the company A’s business is also the maintenance of competitors products, but it is challenging to get reliable data from those to execute predictive maintenance measurements, as the information on its usage or maintenance history can be unknown. Similarly, company E mentions a customer case, where they had set certain data variables that ended up being wrong, which resulted in going back to the original model.

A part of the quality discussion of the data is also the reliability and connectivity of it. The impression from all the companies was that the reliable systems behind collecting the data is vital. Moreover, three of the companies also describe the reliability of the data transferring to have caused some challenges and problems in certain situations. While data transfer and its quality may not be a problem in situations where the connectivity, bandwidth and the expertise of the company are on a good level, the conditions may vary greatly between the industries. Company D describes how the cost is not particularly relevant in situations, where a stable 4G-network can be used. However, connectivity problems can occur in certain cases, where they need to use satellites in ocean applications with varied bandwidth. Transferring user owned data therefore becomes too expensive.

However, the connectivity and reliability of transferring the data may get better in the future with 5G-networks. Furthermore, two of the companies mention 5G, its better latency and speed on both ways to support and have a large impact on the amount of data that can be transferred. Company C describes that it would not only support the existing IIoT solutions with faster real-time transferability, but it would also allow new solutions to arrive that require larger bandwidth. Company D mentions a specific type of service agreements that could also be arranged, which were not possible with 4G to use in specific situations. Concluding that *"5G is gonna be a game changer, if it will sort of make it embed with the satellite network...",* referring that there has been talks around that subject.

6.4.2 Combining the data

Four of the companies express the importance of combining the different data sources. Moreover, the impression from companies A and C was that combining the own data with external sources of data is a crucial factor. While collecting data from own products allows for certain optimizations and procedures, the large enablers for possible new digital business are the combination of own data together with the external sources of data.

“..we are getting closer to the point that the focus is shifting to, well, I probably don’t create too much additional value from the data I collect, but in order to make a meaningful business, I need to collect data from the insurance company, certain type of data from the customer and then from public sources such as the weather information.” Company A

"One of the key things of the Industrial Internet is that you have multiple sources of data. It's not just the data you have in your own IT-system, but you combine certain information from different data sources and with those you create something new that was not previously known." Company C

"...we are looking at the dynamic source of data to be combined with static source of data we have in our databases, and the dynamic source of data actually comes from other companies to analyze with the phenomenon's that could be laid to marketing development..." Company D

Company B also mentions how in a broader view it is important “*not only to have a 360-degree view of own data…but also with external data sources.”*, referring to gathering also data from competitors to see how they compare to them.

Combining the data is also heavily tied into sharing the data between different parties. Sharing can be in this case a mutual agreement between companies to share, buy or sell certain type of data. Moreover, four of the companies mention that they have either already shared data between companies or explored into ways of sharing. However, while company B does not specifically say to have shared, bought or sold data between companies, they have utilized other companies’ data.

Company E mentions that they have companies in their ecosystem for potential data sharing, also referring to a case where they have created an architecture for the data sharing of a digital twin. Company C expresses data sharing through their productized crowd analytics service, which has resulted in new innovations to rise through the combination of data to transportation, movement and logistics to see where and when certain masses are moving. Company D refers to a case, where they have agreed to share the performance of fuel consumption between companies, while also sharing the risks of it: *"We set a baseline. We stay below it; we share the benefits of it. We go above it; we share the pain."* Company D also points out how *"there is a realization, some would say is pretty new, that this cannot be done alone"*. As it is done together with the customers, sharing the data can also enable more in terms of savings.

"One of the things that we've been talking, also publicly...is to bring the key stakeholders of the logistic chain together, start sharing data..." Company D

Company A is starting to explore into ways of who might be interested in the data and could it be transformed into a business. Then further playing with the idea, that maybe the company will use the data themselves, or maybe they could put it into an application interface and open it to some partners or other users and charge from its usage. Similarly, they could purchase and take data from various public sources or others. Therefore, company A concludes there to be a large demand for developing an understanding on how those kinds of data usage agreements could be made, are the company's technical capabilities sufficient enough and what other things to take into consideration. However, a key factor is also for the companies to decide, what kind of data has value and which kind of data to share.

"…each customer and…even my competitors, they might have a different understanding of what data they would like to share, what not." Company D

"...we have to look at what data we can and want to share and to what usage" Company E

Company E also adds the importance on how the technical side is carried out. The costs would start rising, if the company would constantly produce data outwards as well.

Instead, the company is planning to do an architectural on-demand solution, where the data would not be continuously usable, but when needed it would be activated.

One of the main business behaviors regarding to what data to share, as company D points out, is that customers might feel they are giving information about their strategy to the competitors. Adding that *"...one of the biggest challenges at the moment is to agree, which category of machine-generated data doesn't have commercial value."* Further mentioning an example, where an engine manufacturer might get some inside out of a temperature data when compared with the thousands of different installations. At the same time, when individually looked at, it would not be able to get any specifics out of it, except preventing the possible problems or running at higher efficiency, as there are not enough comparable data for it. Yet, the temperatures do not also tell anything about its business.

6.4.3 New business with data

While the companies have utilized the data on various of solutions that supports the current business, the large potential remains in forming new and enhanced digital business. However, creating profitable and scalable new business from data is challenging, as three of the companies express the struggles on those:

"When the basic things have been gotten in order and the basic know-how, I believe there has been kind of a plateau on...how to get the next big thing, where it turns into a business and how to scale it forward from there." Company A

"...probably everyone has the same challenge in that how are we able to create new business from this, and probably everyone is agonizing with the fact that this thing is not advancing quick enough." Company C

"Challenge is...that we are seeing an opportunity, but it's not easy to understand how to embrace it, how to combine heritage, your competence with the new opportunities that you see on the market." Company D

However, two of the companies have managed to create new and profitable business from the Industrial Internet by providing data analytics and IoT solutions to customers. Yet, transforming the data into valuable knowledge and providing data analytics to the customers is only a part of the potential new business opportunities for the companies. Company C describes how the Industrial Internet is very industry specific in that one solution might work for other industries, while not in others.

"There is no generic solution for Industrial Internet. Rather, you have generic technological components, but then it is very industry specific how you are able to utilize it." Company C

One of the possible new business opportunities, where the Industrial Internet can have a large impact is moving from products to outcomes, essentially describing the outcome-based economy. While the companies did not describe any of their developed solutions where this would apply, company A mentioned to have some individual cases of these. Furthermore, two of the companies mentioned its potential role in new BMs:

"I believe that these kinds of as a service models will come more and more and... customers, if they can buy a service instead of them needing to invest, then that kind of interest will grow." Company A

"...helping to change the BM in the business relationships with your customer, you move from products to outcomes...that's where IoT plays a part." Company D

However, which part it plays remains a question. Company A describes those kinds of BMs in general to being more easily executable in smaller products. The major question in larger products is that could the company provide more affordable prices than the customers could get in other forms. In a business case, where a customer would need flexibility, that in certain time of the year the asset needs are higher than in other times, they could pay extra for that flexibility. Other customers asset needs could be the opposite, resulting in using and swapping assets back and forth.

Company A further adds a scenario, where the IoT talk would be turned upside down in a setting where the company would take the responsibility of service maintenance and product lifecycle. In this kind of a setting, the maintenance would be a cost for the company instead of an earning. Yet, this would also result in a conflict, as in the short term it would be lost sales for the company. However, the company could handle the lifecycle more cost-effectively, resulting in cost reductions for customers and be more profitable for the company as well in the long run. Yet, in order for that kind of service model to be profitable for the company, they would need to develop the sensoring needed for maintenance features for less than they would sell the product, resulting in increased balance sheet. While the company and the industry itself has a large influence on whether as a service model is even possible, the two companies who mentioned that are also out of the five companies the best positioned to execute those kinds of BMs.

Essentially, good data analytics has allowed companies to enhance their own operations, but also provide those improvements to the customers. While in most cases that supports the existing products and services, it is also a key in generating new services. Another aspect, where the company E described to have good results is in providing data analysis for customers to optimize their machines. Yet, in this case you are not selling the data or IoT in general, but the knowledge, expertise, models and algorithms, which were able to be formed from that.

6.5 Industrial Internet as an Industry trend

6.5.1 The effects

The overall impression with the companies was that we are still in the early stages of development. Although the technology itself is not new or the problems behind it, as one company points out, the key things are how to utilize the data better in a business activity. As the amount of data keeps growing, companies need expertise to utilize it. Without the expertise, the value from the data cannot be extracted.

"Companies do not really know how valuable the data is, so in a way it has stayed as a crude oil, which would need to be refined to get the benefits out of it". Company B

"You have to have the technical knowledge on how the data is collected and how it can be refined to information, but then you have to have the industry knowledge, so you understand what that information allows in this industry sector." Company C

"...even if there were thousands of points and we're talking about Big Data, in many of the applications, a couple hundred variables are enough for current executions. You have to know what you need to monitor; you don't need all the data." Company E

This is also reflected in the current stage of the results and benefits compared to the invested costs behind them. The overall impression from all the companies was that at this stage, the overall returns and benefits have not outweighed the costs associated with the Industrial Internet. Yet, the payback period with technologies varies between the industries, as the project lifecycles are completely different in B2B than in consumer space.

"I would say that at this point the costs are absolutely higher than the benefits, absolutely. But when you think about if those costs are not done, you never create anything new." Company C

“I would say that the benefits essentially are perceived, but the bulk of them are still to be seen.” Company D

However, providing data analytics and proven models to customers may be an effective and profitable way in some industries. Company E expresses that *"...if not this year, then I would say that next year all the investments we have made in the three years are even"*. Company E varies from the other companies in that they provide break off analytics to customers with easily duplicable solutions for certain machines. Company C also described that their crowd analytics have provided revenue. While the costs might be vastly higher than the returns are now in most companies, and in some instances also for the foreseeable future, company A assesses the Industrial Internet to be *"strategically more important and bigger thing than financially."*:

“The world is changing, and whether we do things, the competitors and others will do things as well, so some things have to be invested and should be invested if you want to survive." Company A

Adding that it is always easy to speculate whether it is a profitable investment, but if the investments were not made and the company would have remained as status quo, then they would die out. Company C also points out how the technological innovations are hard to quantify, but if you would not have them, things would be a lot more complicated. It is up to the company and its expertise to utilize the technology the best they can.

"The forerunner companies that have found the "stake" of the thing (Industrial Internet) will absolutely also get to create revenue, but then the majority of the companies who don't get the "stake" of the thing will only get the extra visibility and maybe reports in more real-time..." Company C

6.5.2 Future implications

The companies spoke positively about the general future of the Industrial Internet. While that is also to be expected from their point of view, the overall future implications were clear.

"...I see that this business will grow extremely in the sense, that when you think about how many factories there are in the world, which do not have any of these solutions." Company E

"...when you have that information available…the sky is the limit on what kind of new innovations could be developed from that." Company C

"...we are clearly investing in this area, because we see that this is the direction the industry is going." Company D

While the talks surrounding the effects of the Industrial Internet were large in the early years of the term's appearance, and since the change and effects have not translated as quickly as maybe originally thought to business performance, as the results of most companies also demonstrate, company C describes the similar nature of the said phenomenon as following:

"If you think about these kinds of previous innovations that has happened, it is that same phenomenon which has occurred that first huge ravings and hype, then goes time and it doesn't really come of anything, then everyone forgets it, then goes 10 years or x amount of years, then suddenly it is everyday life." Company C

Yet, while it poses some questions on its future effects, it allows new ways of working within the companies. In the end, companies can essentially only speculate on its impacts to their overall business. Not all solutions and prototypes end up working, as few companies point out. As there are multiple variables in place, the change does not happen overnight.

"…the procedures are changing, people's working habits, operations and processes are changing, so the change is going to take time…" Company C

"...the beauty of this kind of work, it continuously evolves and it is done in the open together with customers, that's very different compared to the past." Company D

In the future, as technologies and tools evolve, more benefits can also be expected to be extracted from the data. Company B describes how *"in 5 years we are much closer to that we can genuinely combine the different data assets"*, adding that we can get a more comprehensive view from the data, as also the data analyzing tools get better through ML and AI. Similarly, as the amount of data keeps growing year by year, company E adds how in 5-10 years of time *“you cannot use the cloud or AI solutions anymore without automation”*.

7 DISCUSSION

This chapter discusses and summarizes the findings in relation to the theoretical framework and author's observations. Moreover, a sustainable value creation process of the Industrial Internet is introduced based on the empirical observations. Furthermore, this chapter concludes the research by discussing the theoretical- and managerial implications, as well as the limitations of the study.

7.1 Summary of the study

The aim of this study was to research the Industrial Internet and its sustainable value creation effects between different companies. The research questions were:

1. How does the Industrial Internet affect the sustainable value creation of companies?
2. How does the sustainable effects and solutions of the Industrial Internet vary between the different companies?

As there was a relatively small amount of research done regarding the subject due to the novelty of the topic, the study aimed to contribute to the existing theory as well as potentially support new theoretical findings.

Industrial Internet in sustainable value creation of companies is a diverse subject, as there are multiple factors to take into consideration. First of all, sustainable value creation is extremely hard to quantify in the case of the Industrial Internet, as seen in the empirical findings. The value it creates can essentially be measured case by case basis, essentially comparing the results prior to implementing the solutions. Even then, the measurable value can differ in cases, where it is not clear how much of the measured value can be contributed directly to the Industrial Internet. This is also supported by the theoretical framework, which demonstrates the difficulty of describing the measured value of IIoT solutions in numerical terms (Höller et al. 2017: 70). However, the findings indicate that the Industrial Internet brings a lot more sustainable value creation opportunities, that would otherwise be lost. The quantified value that the Industrial Internet creates is only a part of the reason the companies are investing in it. As seen in most cases, the current stage results and sustainable value the Industrial Internet brings to the companies is not, where they would ultimately want it to be. While we should also be skeptical about the potential measured results it could provide, we are still in the early stages of the process. As value can also take many different forms such as captured, un-captured, visible, invisible and missed (Yang et al. 2017: 31-33), a direct correlation to the measured results should not be taken.

Companies can monitor and optimize existing and new processes, which brings value, but the sustainable value it creates is still relatively slim, essentially describing the first stage in Figure 8 (WEF 2015). The large sustainable value creation factors are the new products, services and partnerships, that the technology allows. The results reflect, that the new BMs the Industrial Internet allows for companies are providing data analytics to customers or moving towards a service model with products. Those BMs can create value for all stakeholders, which is in-line with the theoretical BM value-centered logic (Zott & Amit 2013: 403-404). While the theoretical implications were clear on service models as a possible new BM for companies (Gilchrist 2016: 10; Schaeffer 2017: 55), the selected ones had not been able to successfully transfer to the model, as their execution depends on the companies' assets and their sizes. However, the theory did not implicate data analytics as a sellable service to the customers. Yet, providing data analytics to customers is also, where two of the companies described creating sustainable value. Moreover, the company that indicated in creating most of its measured sustainable value with the provided data analytics had also the best measured results of the current stage amongst the companies. However, the findings indicate that it is very industry specific, whether any of those models are executable in certain companies. Not all companies can provide data analytics for customers or offer service models for products. Yet, an incorporation of both by providing a service model and additional information to the customer by its more efficient usage is implied in theoretical framework (Greengard 2015: 60-67; Kotler et al. 2016: 148). However, the service models seem to describe the longer path for the companies, which results could be seen more in the future, while providing data analytics to customers can provide relatively fast results for companies that can utilize it well, as seen in the findings.

While the Industrial Internet attracts new challenges, the companies expressed relatively small number of factors compared to theoretical framework. The main issues that arouse through the findings were related to data security, legislation and technical side of the data collection process. New data-related legislations such as GDPR had caused excess amount of work for companies, that operated with personal data. Theoretical implications also describe cyber security and legislation as one of the largest challenges of the Industrial Internet (Perera et al. 2015: 33; Chike 2017: 4-18; Müller & Voigt 2018: 664). Yet, not all companies described those to have caused any challenges. Instead, a few referred them as a non-issue or even an opportunity. The results indicate that while cyber security is a challenge for most companies' in general terms, the actual data collection process may be relatively safe. Findings related to the technical side of challenges were regarding the connectivity, quality and processes of data collection. While theoretical framework does not implicate those factors, they may be indicated in research related more towards the technical side of IIoT implementations. Nonetheless, the findings indicate no connection towards theory implicated competitiveness, adaptation or acceptance towards the Industrial Internet. This could be, as the companies are used to dealing with the competitive environment, so it is more of a norm than a challenge for them. Moreover, the general success of adaptation depends on the competence of the companies, hence it may be a challenge for lower competence firms. While the general acceptance towards the Industrial Internet was not brought up, it is not necessarily an indication that it would not be a challenge, as the interviewees describe a target group where this does not apply. Instead, workers who may have had to change their role, working habits or gotten additional training for Industrial Internet could have differing opinions.

In the light of the empirical findings, Figure 11 strives to describe the companies' current sustainable value creation process of the Industrial Internet.

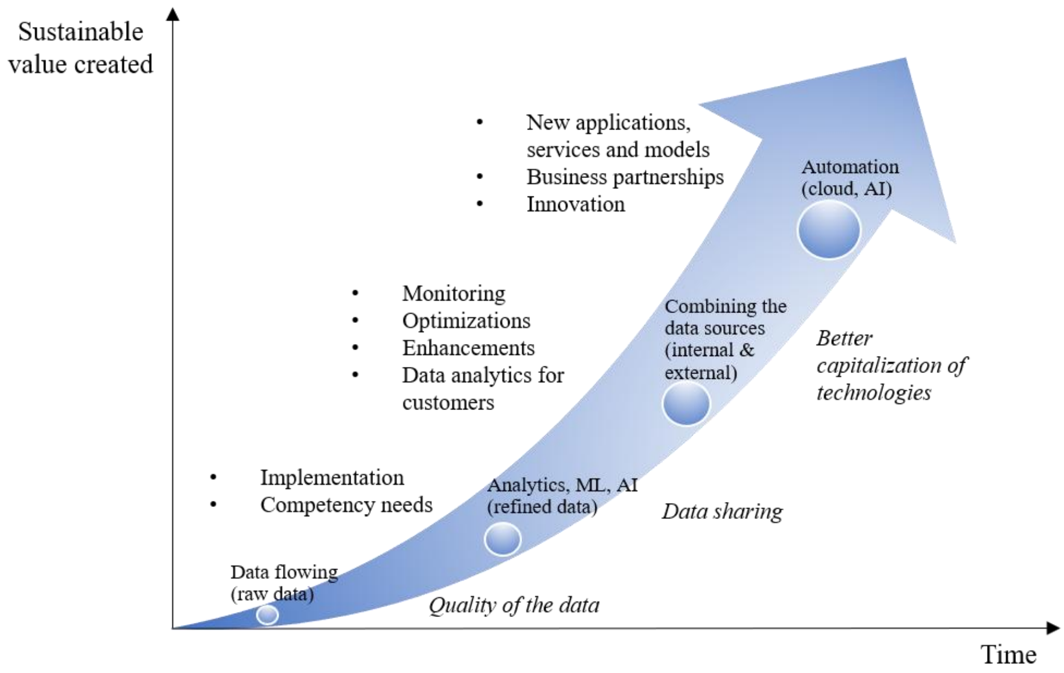

Figure 11. Sustainable value creation process of the Industrial Internet.

The results indicated that in the early stages of implementing the Industrial Internet, new competency needs are clearly required by the companies. While the theoretical implications are similar towards new competent workers to be hired (Birkel et al. 2019: 8), the general theoretical consensus was unclear on whether the Industrial Internet will increase or decrease the amount of work (Bonekamp & Sure 2015; Beier et al. 2017: 232-233; Müller et al. 2018: 3; Müller & Voigt 2018: 664). Yet, no company described a loss of jobs, but instead a few companies mentioned it greatly increasing the amount of work. However, while that is not large enough sample size to make proper conclusions, it also depends on which stage to approach it. Is the discussion about the current stage of the Industrial Internet, future stages or the general overall impact? If we can assume, that in the first stages the amount of required internal work clearly grows through new competency needs as implicated by the companies and theory, then what happens in the later stages? Organizational change takes time and the transformation does not happen overnight. We do not know, whether it takes 5 years, 10 years or 20 years to approach the next stages towards fully automating the processes. Moreover, it is unclear whether we can even fully automate it, as that also brings additional risks in place such as inspecting the correct parameters, as one company pointed out. Yet, it seems clear that new competency needs are not disappearing, as technological advancements and innovations are constantly sought after. It is a matter of whether the jobs that might become obsolete will be changed in a value chain or get destroyed completely.

When the actual data can be gathered, it then allows the possibility to extract value from it. However, as the results indicated the data is not able to create sustainable value by itself, it can be expected that at that stage, no value has been created. As the quality of the data was an important finding regarding the validity of data analytics, it needs to be highlighted in order to successfully move on to the next stage. While the theory did not specifically describe the importance of data quality, the improvement on processes and data analysis was described (Thoben et al. 2017: 6-13), as the amount of data keeps growing (Bloom et al. 2018: 9). When meaningful data analytics can be performed, various results of created sustainable value could be expected through monitoring and better optimization and enhancements to the existing products and services, as also indicated by the companies. Economic value is created through cost reductions to the existing processes such as energy- and fuel consumption, which is also supported by the existing theory (Evans & Annunziata 2012: 3-4; Kagermann et al. 2013: 25-27; Beier et al. 2018: 3-7). The amount of value it creates is dependent on the amount of processes and assets it could be utilized on, as indicated by the companies. The more the assets, the larger the potential effect of improvements.

Products and processes can be monitored more efficiently, reducing the need to travel and allowing to detect potential failure risk in products parts. While the monitoring of processes, allowing the ability to perform predictive or dynamic maintenance is well described in theoretical implications as a large potential factor (Anderl 2014: 5-10; Marques et al. 2017: 302-308; Hunke et al. 2017), the reduced personnel travelling is not highlighted despite the majority of companies referring to it. Yet, while the theoretical implications also indicate the general transparency to allow improvements to various factors (Beier et al. 2017: 232; Müller et al. 2018: 2; Beier et al. 2018: 8), the companies hardly mention it. As the products can be optimized and traced, it allows the improvement to the overall production levels and efficiency. At this stage, the economic value also effects the ecological value, as those improvements and enhancements allow the greenhouse gas emissions to be reduced, essentially correlating with each other. Safety can also be improved on existing products by allowing better working conditions, thus potentially creating economic as well as social value through less work-related accidents, as indicated by most of companies and theory (Evans & Annunziata 2012: 17-30; Patala et al. 2016: 146; Müller et al. 2018: 6-8; Müller & Voigt 2018: 665). Being able to gather qualitative data also allows the possibility to provide data analytics for customers, which can potentially create the most economic value at this stage. However, while sustainable value can be created through different measures, the overall invested costs are likely to still be a lot higher. Theoretical implications also support the short-term profitability of the Industrial Internet to often be negative (Birkel et al. 2019: 9).

In addition to internal improvements, and possibly providing those improvements to the customers, is moving towards combining the different data sources, which then allows for new opportunities through innovation towards applications, services and models. The combination of different data sources was a crucial finding in this study, as it allows new services to potentially arise through that. Moreover, while most of the companies described the combination of different data sources to be vital, theory did not implicate any sort of data combinations. The reason for this could be that it is linked more towards on how the technical side is carried out, thus not being included in thesis' theoretical framework, or it could be a case of theory not being fully caught up on the current stage of companies. Either way, the majority of the companies were extremely adamant on the importance of it in their current stages. New services, such as a service model can provide economic and ecologic value through more sales in the long run and providing more efficient lifecycle and products usage, thus also being better for the environment. Yet, while the companies are not yet at that stage, where profitable as a service models would have been implemented, its potential is easily observable. Additional safety services can also be made, which combine the different data sources, creating economic and social value. Yet, it is then very industry and company specific on how much, or if any, those services are able to create sustainable value. As the combining of the data is also tied with the sharing of the data, it allows new partnerships to be made. Therefore, strengthening the existing industry-wide relationships by sharing the data between various partners to mutually benefit from it. While hard to assess its effect, the potential sustainable value it could create may end up being invaluable. As the amount of data keeps growing at that stage, it becomes harder to assess it without automation. Capitalizing and improving the technologies better is therefore a must.

As the findings indicate, most of the companies are constantly trying to develop something new from the data. Yet, that is also an area where the companies generally struggle the most in creating profitable ones, as typically the solutions support the existing processes and services. While that is fine itself, the ambition of developing something new from data that could be laid to the customers is an intriguing one. First off, being the first one on the market with a new solution is a major advantage, as it allows a certain time period of monopolization and first contact to the new customers. As with all the companies' products and services, being interested in one solution could also lead to being interested in the companies' other solutions as well through synergy and being more exposed to them. This also ties into the sharing of the data, which can create large benefits for companies, as the results demonstrate. New opportunities therefore promote innovation and innovation brings new solutions. In this sense, not investing into the Industrial Internet would essentially end up creating value loss, as new partnership deals or services regarding data could not be arranged and developed.

Industrial Internet also allows the companies to improve and enhance their existing products and services. Yet, it is also hard to estimate how much value would be lost if those improvements would not have been made. As the digitalization of processes brings a lot of competition between companies, it benefits the customer in being able to pick the best option amongst the improved products and services. Theoretical framework also implicates Industrial Internet to enhance competitiveness by strategic differentiation (Kiel et al. 2017a: 8-11). Yet, the better individualized solutions the Industrial Internet could provide are also argued to lead to better customer satisfaction rates and ultimately to larger volumes of sales (Kagermann et al. 2013: 22, 33). However, if the company would choose to not invest in the competitive environment of the Industrial Internet, it could become detrimental to the company itself. Essentially, while the other companies could provide improved products and services, the others could not. It could therefore be assumed, that the status quo company would have a hard time attracting new customers and partners and be also at risk of losing a lot of their current ones. Birkel et al. (2019: 10) also highlights that in the Industry 4.0 era companies can lose their market share by not providing adequate digitalized solutions. Therefore, making a strong case to invest into the Industrial Internet as a strategic move to prevent potential sustainable value loss. However, this also begs the question on whether the Industrial Internet is essentially the “necessary evil” for the companies to survive in the competitive market. While the findings clearly indicated similar effects on many of the companies' solutions, their executions varied based on industry sector, customer segments and assets. As with all technologies, some companies can utilize it better that the others. Ultimately, it is up to the expertise, industry and company itself to extract the most sustainable value out of it.

7.2 Theoretical- and managerial implications

The research has notable theoretical and managerial implications. It contributes to the existing theory by supporting many of the existing findings regarding the benefits and sustainable value creation opportunities of the Industrial Internet. Yet, it also supports the general uncertainty towards the expected short-term results, which depends on the industry and its competence. As the large results the Industrial Internet could bring are yet to be seen, the theoretical implications make a lot of assumptions regarding its future effects. The study contributes to bring a small amount of flesh to the bones by filling the gaps in the current stage of the study’s companies, which indicate that in most cases the early internal executions that bring benefits are not that significant financially. Yet, the longer-term results are more than just the financial returns.

While the findings support the theory in challenges regarding data security and its legislation, it also fills the gaps between where the security may not be an issue. The study also fills the gaps regarding the work and competency needs of the Industrial Internet. While there were studies arguing the digitalization and Industrial Internet to increase the amount of work (Evans & Annunziata 2012: 28; Gerbert et al. 2015; Hofmann & Rüsch 2017: 24), the consensus is highly uncertain. Yet, the findings highly support new and additional competency needs and work in its current stage. The study also contributes in forming potentially new quest on theory, as findings towards data quality and the combination of various internal and external data sources were perceived as crucial elements by most of the companies regarding reliable data analysis and creating digital business. The results also indicate data analytics as a service for customers to potentially be a highly effective BM for certain industries, that can execute it properly.

The managerial implications of the study could be significant for companies in the early stages of implementing the Industrial Internet or planning whether to invest in it. A sustainable value creation process of the Industrial Internet was presented (Figure 11) through the findings of the study, which describe the key factors, stages and expected sustainable value created through implementations. That can help the companies to make priorities and decisions in order to successfully implement the Industrial Internet and see which parts are crucial and where can value be expected. The study also makes a hypothesis that investing into the Industrial Internet is necessity to stay competitive. As the findings indicated, investing into the Industrial Internet is a lot more than the sustainable value it could create. Companies should take into consideration the strategic effect through potential differentiation and business partners, as well as the potential sustainable value loss through not enhancing offerings as much as other companies that had invested. While the implications to companies that are in similar stages than the study's companies are likely to struggle with a lot of the same things, it could also benefit them in seeing the other companies' opinions and solutions to see whether certain implementations could also work in other industry sectors as well.

7.3 Limitations and suggestions for further studies

As with all qualitative research, the findings are not indicative to any generalization of the specific results. The number of interviewees is also too low to draw any definite conclusions. In order to achieve conclusive evidence through the interviews, the sample size would need to be significantly higher. Yet, regarding the topic and the qualitative nature of the research, accessing that amount of individuals where those kinds of conclusions could be made would have been unachievable for this master's thesis.

The selected individuals also pose a limitation, as they were not approached randomly thus they represent expertise on the subject, but more in terms of where the access was possible to be gained through a mutual connection. Another aspect is in the views of the interviewees, which do not necessarily represent the company view in all situations. As the interviews were semi-structured and had a time-limit, the structure varied on where the interviewee took the conversation. Certain parts of the pre-determined questions were also left out in some instances, where time became an issue and the question was partly already answered in other sections of the interview.

Further studies could focus more in a specific aspect of sustainability, rather than all at once. As the Industrial Internet itself is a broad subject, incorporating all the sustainable value creation elements into it results in only really scratching the surface. More in-depth views could therefore be gathered by studying a specific sustainable element's effect on the Industrial Internet. While multiple different industry sectors seemed appropriate for this study to have various views and results, more insights could also be gathered by focusing on a single industry's impact on the Industrial Internet. As the study indicates, new digital BMs are the large potential factor in creating the most sustainable value. More studies could focus on the new BMs the Industrial Internet provides, their implementations, results and factors in succeeding with them. Moreover, studies regarding non-quantified value, such as strategic value or potential value loss in case of not investing in the Industrial Internet should also be researched to better understand its effect.

In conclusion, the topic of Industrial Internet in sustainable value creation of companies is a broad and new subject. It is essential to understand the nuances and consequences it brings to the companies, as it is an enabling technology for future success. Therefore, more research is needed to better understand the requirements, value creation opportunities and challenges it poses.

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APPENDICES

APPENDIX 1. INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

- Name / Company / Title [anonymity]
- Time / Date / Place
- Experience on Industrial Internet?

Present sustainable value creation opportunities and challenges of the Industrial Internet:

1) In what ways have you implemented the Industrial Internet / IIoT-solutions into the business? Are you able to tell more about them?
2) What have been the biggest opportunities that the Industrial Internet has provided? Examples?
3) What have been the biggest challenges that the Industrial Internet has caused? Examples?
4) What are the sections, where the IIoT-solutions have had the largest impact?
    - Positive?
    - Negative?
5) How do you deal with the data from internal and external sources?
    - Has there been issues regarding data handling and / or security?
    - Who owns the data?

Sustainable impacts of the Industrial Internet:

6) How would you define sustainability?
7) Which economic factors have you encountered after the implementation of the Industrial Internet?

8) Which ecologic factors have you encountered after the implementation of the Industrial Internet?
9) Which social factors have you encountered after the implementation of the Industrial Internet?
10) Has the IIoT-solutions brought measurable value? Examples?
    - How was it measured?

Sustainable Industrial Internet, expectations and future:

11) How big of a sustainable impact are you expecting the Industrial Internet to have on the company?
    - How are you going to achieve those expectations? Any specifics?
    - What are the possible estimates based on?
12) At this time, has the accumulated benefits, profits and / or cost-savings outweighed the actual costs associated with the Industrial Internet?
13) What are your future expectations regarding the Industrial Internet?

14) Anything else you would like to share?

APPENDIX 2. INTERVIEW QUESTIONS (FIN)

HAASTATTELU KYSYMYKSET

- Nimi / Yritys / Positio [anonymiteetti]
- Aika / Päivämäärä / Paikka
- Teollisen Internetin kokemus?

Nykyiset Teollisen Internetin kestävän arvonluonnin mahdollisuudet ja haasteet:

1) Millä tavoin olette ottaneet käyttöön Teollisen Internetin / IIoT-ratkaisut liiketoiminnassanne? Voitteko kertoa enemmän näistä?
2) Mitkä ovat olleet suurimpia mahdollisuuksia, joita Teollinen Internet on tuonut? Esimerkkejä näistä?
3) Mitkä ovat olleet suurimpia haasteita, joita Teollinen Internet on aiheuttanut? Esimerkkejä näistä?
4) Mitkä ovat tekijöitä, joissa IIoT-ratkaisujen vaikutus on ollut suurin?
    - Positiivinen?
    - Negatiivinen?
5) Miten käsittelette dataa sisäisistä ja ulkoisista lähteistä?
    - Onko datan käsittelyssä ja / tai turvallisuudessa ilmentynyt ongelmia?
    - Kuka omistaa datan?

Teollisen Internetin kestävät vaikutukset:

6) Miten määrittelisit kestävyyden? (*Sustainability*)
7) Mitä ekonomisia tekijöitä olette kohdanneet Teollisen Internetin käyttöönoton jälkeen?
8) Mitä ekologisia tekijöitä olette kohdanneet Teollisen Internetin käyttöönoton jälkeen?
9) Mitä sosiaalisia tekijöitä olette kohdanneet Teollisen Internetin käyttöönoton jälkeen?

10) Ovatko IIoT-ratkaisut tuoneet mitattavaa arvoa? Esimerkkejä näistä?
    - Miten tämä on mitattu?

Kestävä Teollinen Internet, odotukset ja tulevaisuus:

11) Kuinka suuren kestävän vaikutuksen ajattelette Teollisen Internetin tuovan yritykselle?
    - Miten aiotte nämä saavuttaa? Näihin liittyviä erityisiä toimenpiteitä?
    - Mihin mahdolliset arvionne perustuvat?
12) Ovatko Teollisen Internetin tuomat hyödyt, tuotot ja / tai säästöt olleet tällä hetkellä suurempia, kuin tähän uponneet kustannukset?
13) Mitkä ovat tulevaisuuden odotuksesi Teollista Internetiä kohtaan?

14) Onko jotain muuta mielenkiintoista, josta haluaisit kertoa?