Industry 4.0

Cyber-Physical Systems and their impact on Business Models.

Industri 4.0

Cyber-Physical Systems och deras påverkan på Affärsmodeller.

Linus Åkeson

Health, Science and Technology

Master of Science in Industrial Engineering and Management

Master thesis: 30 ECTS

Johan Quist & Jan-Erik Odhe

Mikael Johnson

2016-06-30

Serial number: 1

Abstract

Industry 4.0 is one of the fastest growing topics amongst both practitioners and academics. To this day, no definition of Industry 4.0 has reached consensus. However, some definitions can be considered more correct than others and the most accurate one is summarized as "Industry 4.0 is a concept for creating value throughout the whole value-chain". This has been made possible through digital solutions, advanced technologies, which often are associated with Industry 4.0. This thesis started off finding the key aspects of Industry 4.0 and through a literature review it was concluded to be Cyber-Physical Systems (CPS) which will bring new innovative Business Models. The fundamental aspect of Industry 4.0 is data, data which has become available through the usage of CPS, data which will transform how business are conducted. This thesis aims to develop a better understanding for how CPS affects the Business Model.

The thesis started with a literature review, investigating the value of information in a digitalized era. It was established that the value is found in the capability to monitor, remote control, optimize, and automate products and machines. Furthermore, it was also established through the literature review that manufacturing industries are becoming more services-focused and that value-creation is done through networking. Moreover, the Business Model Canvas was embraced as theoretical framework for what a business model should consist of.

Data was gathered through semi-structured interviews with experts on the subject of Industry 4.0 and digitalization. The data was then compared to the theoretical framework.

The results showed that CPS will not affect business models in any direct way as it is very well founded that the business model always should be based on the customer segment. However, CPS did have an indirect impact on business models i.e. through expected changes in customer relationships and distribution channels, but foremost, through changes regarding specialization and partnerships.

Keywords:

Industry 4.0, Digital Transformation, Cyber-Physical Systems, Business Model Canvas, The value of Information, Specialization, Partnerships, Servitization.

Acknowledgements

First off, I would like to thank my tutors Johan Quist and Jan-Erik Odhe for their support and guidance throughout this thesis. Secondly, I would like to thank Erik Widing, my contact at Prevas, whom made this thesis possible through his network and Prevas customers.

I would also like to thank the participants; Lars Celano, Thomas Stetter, Johnny Lundberg, Niklas Wass, Jan Tegevall, Andreas Rosengren, and Magnus Bårdén, your expertise and openness made this thesis possible.

Linus Åkeson

2016-06-30

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List of Abbreviations

CPS – Cyber-Physical Systems

BMC – Business Model Canvas

CBM – Component Business Model

IoT – Internet of Things

IoS – Internet of Services

ERP – Enterprise Resource Planning

MES – Manufacturing Execution System

CRM – Customer Relationship Management

PLM – Product Life-cycle Management

KPI – Key Performance Indicators

1. Introduction

This thesis has its foundation in the current developments of Industry 4.0. The first chapter is thereby conducted with the purpose of introducing the reader to the background and key aspects of Industry 4.0. Furthermore, this section will clearly state why this research is needed and then present the aim of the study.

1.1. Background

1.1.1. Industry 4.0

Industry 4.0 is one of the fastest growing research topics for both practitioners and academics (Hermann et al. 2015). The term "Industry 4.0" was first mentioned in 2011 and was strategic plans developed by the German federal government for the high-tech manufacturing industry of tomorrow (Hermann et al. 2015; Koch et al. 2015; Nathan 2015). However, as they all discussed, there is no definition of Industry 4.0 which reached consensus. Hermann et al. (2015) states that this is a major problem since the large focus the subject has received in recent times means that more and more deviant definitions is coming every day. Nevertheless, some organizations have achieved the role of key promoters, and their definition could be considered "the right one". Both the literature review done by Hermann et al. (2015) and the quantitative study performed by Koch et al. (2015) relies on the definition provided by "Plattform Industrie 4.0" even though both research teams argues for that it is to diffuse to provide necessary fundamental understanding of Industry 4.0. Plattform Indstrie 4.0 (2014; Koch et al. 2015) defines it as:

> "Industry 4.0 is best understood as a new level of organizational control over the entire value chain of the life cycle of products, it is geared towards increasingly individualised customer requirements. The basis of the fourth industrial revolution is the availability of all relevant information in real time by connecting all instances involved in the value chain. *translated from German.*

As the definition is blurred, Hermann et al. (2015) conducted a literature review of Industry 4.0 with the goal of establishing key aspects and key principles for Industry 4.0. They found that there are four aspects which are to be considered key aspects of Industry 4.0; *Cyber-Physical Systems (CPS)*, *Internet of Things (IoT)*, *Smart factories*, *Internet of Services (IoS)*. However, Heppelmann and Porter (2014) stated that the Internet is mere a communication mechanism i.e. the IoT and

IoS should not be considered techniques deriving from Industry 4.0 rather than concepts made possible through technologies as CPS.

Furthermore, Kolberg and Zühlke (2015) defined a Smart factory as a factory consisting of *Smart machines*, producing *Smart products*, operated by *Smart operators*. Smart machines and smart products are made possible by *CPS* (Hermann et al. 2015; Kolberg & Zühlke 2015).

Moreover, Koch et al. (2015) conducted a quantitative study asking 235 German companies what Industry 4.0 are and how it will contribute to the manufacturing industry. The results were presented as key perspectives and motivations of Industry 4.0. The key findings were:

- The industrial internet (Which they state is just another name for Industry 4.0) will change the whole business and it is very important that the management is dedicated.
- Integrated analysis and use of data are the main capabilities of Industry 4.0
- Digitalization of products and services (Smart products)
- New disruptive business models.
- Horizontal cooperation throughout the whole value chain

Koch et al. (2015) clearly argued for that Industry 4.0 substantially is about new innovative *business models* embracing the new possibilities emerging from the use of new technologies *(Smart products)*. As they (ibid.) argued for that it is the new *business models* which will make the new technologies fruitful.

Brettel et al. (2014) has also conducted research showing that new technologies open up for new *business models* which are developed with the aim of transforming available data into value for the whole value chain. Furthermore, they stated that it is *CPS* which will make all this possible (ibid.).

More research (Mittermair 2015; Nathan 2015) has strengthen the above stated key aspects as both these studies has shown that the foundation of Industry 4.0 is data and it is made possible through *CPS*. As new data are becoming available in real-time, from new sources, Mittermair (2015) and Nathan (2015) both argues for that the new innovative *business models* need to be developed to make sure that companies benefits from the digitalization.

Key aspects of Industry 4.0

From the above mentioned researches, key aspects for Industry 4.0 has derived and those which achieved most focus in all referenced studies above were *CPS* and *Business Models*.

1.1.2. Cyber-Physical Systems and business models

Sciocchetti (2014), an employee at Bosch (one of the leading edge companies of Industry 4.0), stated in her blog post that the real revolution within Industry 4.0 is in business models. This is further elaborated on by Herterich et al. (2015) and Heppelmann and Porter (2014) which stated that Industry 4.0 enables new innovative business models developed to utilize all new possibilities and foremost all new available data, associated with the high-tech Industry 4.0. Research has established that it is CPS which makes smart products and this level of data leverage possible. Thereby, it is concluded that in its foundation, Industry 4.0 is about data. Data which will make it possible for businesses to create value in new innovative ways and thus, transform existing *Business Models*; this data is made possible through *CPS*. (Brettel et al. 2014; Kolberg & Zühlke 2015; Herterich et al. 2015)

New innovative business models are needed to capture the value made available by CPS as CPS will make it possible to monitor, control, optimize, and automate products and machines to a whole new level (Heppelmann & Porter 2014; Herterich et al. 2015). For example, after-sales monitoring will open up the possibilities to improve and develop existing products to fit more to the usage e.g. minimize overengineering. Furthermore, market segmentation can be done more precisely by the analyse of usage patterns. The capability of monitoring the products also opens up a whole new world of after-sales services directly made possible by real-time data, made available through CPS. Moreover, by the use of CPS a new level of control can be reached e.g. products can be controlled by algorithms or by remote commands which makes it possible for the product to adapt to changes in its operating milieu. Also, by the possibility of remote controlling the product performance can be directly customized to the customers' usage. CPS will make it possible to collect huge amounts of data in real-time which makes it possible to optimize the performance as the real-time data can be analysed and utilized for preventative maintenance which will minimize downtime (ibid). When CPS is used to its full potential products can combine monitoring, controlling, and optimizing to become autonomous, not

only by the process itself but it will also have automated the decision-making process. (Ford 2015; Herterich et al. 2015; Heppelmann & Porter 2014)

The above mentioned abilities, made possible through new technologies and CPS, opens up for new ways for the manufacturing industries to create value (Koch et al. 2015; Brettel et al. 2014). However, as the manufacturing industries traditionally only focused on manufacturing and selling tangible products (Herterich et al. 2015) they need to be responsive towards this shift in creating value, as Industry 4.0 and CPS are about to change the whole landscape of manufacturing (Heppelmann & Porter 2014). The new possibilities emerging from Industry 4.0 will bring new partnerships, development of customer relationships, new distribution channels, new cost structures, and new revenue streams, all of them crucial for business model generation, development and innovation (Osterwalder & Pigneur 2013).

1.2. Aim of thesis and Research questions

From the introduction section above it is evident that CPS will play a major part in Industry 4.0. Furthermore, to benefit the most from Industry 4.0 and all the new possibilities deriving from the new technologies, such as CPS, new business models are needed which embrace these new capabilities. However, no found research has been conducted with the purpose of establishing *how* business models should be generated and developed to actually embrace Industry 4.0 and utilize CPS.

The aim of this study is therefore; to understand and analyse how business models is affected by Cyber-Physical Systems and how to generate Cyber-Physical System-utilizing business models.

From this aim the object of this study is identified as: To understand as for how to generate and/or develop Business Models utilizing the possibilities emerging from the use of CPS. Furthermore, as the definitions of Industry 4.0 is vague a literature review is at hand before introducing more specific research questions. The research questions can be found in chapter 2.4.4 *Research questions.*

1.3. Thesis outline

This thesis will be read by post graduate students in Industrial engineering and management, university staff, and consultants active in the business of industrial ICT and Automation. The focus is not on the technical aspects of CPS rather than how they affect business models and the basic level of ICT understanding associated with engineering students will be sufficient. Furthermore, the thesis will not discuss or study the concept of smart products, although, it is mentioned and used as a motivation for the CPS approach. Moreover, sustainability aspects will shortly be introduced to provide the reader with a broader understanding but will not be of focus throughout the study. These limitations are necessary as the thesis are under strict time limitation of 20 weeks.

Chapter 2 will introduce the reader to theories needed to follow the thesis and to understand its result. This means an in-depth description of *The value of information*, *Business Models*, and *Cyber-Physical Systems*. This chapter ends with a presentation of the theoretical framework and the research questions.

Chapter 3 will present the methodology used for this thesis. This section will motivate and discuss the chosen *research strategy* and *design,* and how the research proceeded with *data collection* and *analysis*. Chapter 3 ends with a discussion around the thesis' *trustworthiness*.

Chapter 4 will present the empirical data found. In this case, the data collected from interviews. Presented from two perspectives, represented by two personas, The Reacher and The Settler.

Chapter 5 is the analysis section which will host the comparison between the theoretical framework and the findings which will culminate in the conclusion.

Chapter 6 will introduce the reader to the findings and conclusions.

Chapter 7 is the final chapter of this thesis and will introduce the reader to a discussion around the conclusion and how the results will contribute to the research area and also give pointers for where future research is needed.

2. Literature-based frame of reference

This section is conducted with the purpose of providing the reader with a fundamental understanding of theories which the study is based upon. Thereby, ideas and models established by academics are introduced together with a short discussion around each topic. Furthermore, this chapter ends with a presentation of the theoretical framework representing the summarized "reality" embraced when doing the empirical study and analysis.

2.1. The value of information

As established in the introduction section, Industry 4.0 is in its foundation about data. Data which is becoming available through the use of CPS. Also, it was established that this data opens up for new innovative business models which can transform the data into value. Therefore, this section will provide the reader with a fundamental understanding for the value of information in a digitalizing era.

2.1.1. Smart products and value-creation through data

Traditionally products were composed of solely mechanical and electrical parts and Manufacturing industries' business models were based on creating value for their customer seldom through their physical products (Heppelmann & Porter 2014). With the use of CPS, products have transformed into whole systems combining the traditional mechanical aspects of a product with new high-tech aspects such as sensors and microprocessors, data storage and software as well as connectivity, transforming an optimized mechanical product to a smart product (ibid.). A product which is stretching its value-creation capabilities far beyond the mechanical, physical boundaries. This means that more data, and new types of data, will become available in real-time, data which opens up for new innovative ways of creating and capturing value (Heppelmann & Porter 2014; Herterich et al. 2015). To be mentioned is that value-creation through utilizing data is not new, business analytics, the use of data for decision-making can be traced back to the 1950s (Cao et al. 2015). However, except that with more data available the decision-making process will be more efficient (ibid.), these smart products will open up for value-creation far beyond the inter-organizational value-creation of decision-making efficiency (Heppelmann & Porter 2014).

Barton and Court (2012) emphasized that data-driven strategies will drive competitive differentiation. This statement has its foundation in the subject of decision-making as primary value-capturer.

Both Barton and Court (2012), McAfee and Brynjolfsson (2012), and Cao et al. (2015) focused on how data created value through data analyse e.g. Cao et al (2015), defined decision-making efficiency as a company's proficiency at making real-time decisions, respond to change, and their understanding of their customers. In other words, the traditional value of data was to optimize and improve the decision-making process making sure business stayed competitive through continuous optimizing and development (Barton & Court 2012; Cao et al. 2015; McAfee & Brynjolfsson 2012). However, with the introduction of smart products, the focus has shifted from optimizing strategic decisions, and instead Heppelmann and Porter (2014) argues for a fundamental transformation of business models. Of course, smart product will also contribute to decision-making efficiency in a traditional meaning (Heppelmann & Porter 2014; Herterich et al. 2015) but the real capabilities for creating value erupting from the use of smart products are coupled to *new* types data stretching beyond decision-making support (Heppelmann & Porter 2014). Heppelmann and Porter (2014) introduced four levels of data utilization made possible by the introduction of smart products:

- Smart, connected products enables extensive and intensive ***monitoring*** of a product in use. The product's condition can be monitored in real-time. Furthermore, the possibility to monitor stretches to the operation of in which the product is used and in which environment it is placed, providing the manufacturer with data making it possible to improve and optimize its functions. Monitoring also opens up for a large variety of after-sales services, depending on your business model and how to create and capture value.

- By the use of embedded systems, the capability of remote ***controlling*** is made possible and through remote commands or algorithms you can tell the product to do specific task when specific requirements are met e.g. as a safety mechanism a valve could open at a specific pressure.

- If monitoring and controlling is combined, the rich flow of information and capability of remote controlling enables ***optimization***. With real-time data over performance available the product-performance can be optimized to a level not yet possible. Furthermore, with real-time data of products condition made available and product control capabilities, firms can provide services like preventative maintenance. This new level of service capabilities opens up for a lot of new innovative business

models. Such as business models embracing the "product-as-service" logic where customers only pay for usage instead for the physical product. This generates a collaboration between companies creating value together.

- The last level of data utilization is when the three earlier introduced levels are combined a whole new level of ***autonomy*** can be achieved. Mittermair (2015) introduces the saying "Automation of automation" which sums it up pretty well. By combining all these aspects, the products will become able to learn about their environment and the process in which they are used, and thereafter optimize themselves. They would be able to self-diagnose their service needs and alert the service technicians.

Parmar et al. (2014) explained that the true change of the ongoing and forthcoming digitalization is new business models. The true change coming with smart products is what companies now *could have access to* in the meaning of data and analytic tools. They emphasized on that there are major opportunities for business development coming from this digitalization. Therefore, Parmar et al (2014) described five patterns for how business can create value through the use of data:

- The first pattern discussed by Parmar et al. (2014) aligns with Heppelmann and Porter's (2014) first level of data utilizing. **Augmenting products to generate data** is the first and most fundamental pattern for utilizing data. By providing products with gear capable of collecting data products can be monitored, improved, and optimized.

- **Digitalizing assets** are emerging and replacing traditional physical aspects e.g. as Nathan (2015) explained in his research; automotive manufacturers can move the design process from the physical world i.e. clay, to a virtual world.

- **Combining data within and across industries** is now possible. Businesses can combine data from their different operations and thereby cooperate to help each other develop their products and services based on data which was not available through their own products and services.

- The **trading of data** is the next pattern found by Parmar et al. (2014). Businesses especially good at gathering the right information and utilizing found data may trade this data to other businesses also suffer from the same problems. For example, Vodafone are selling data collected by their mobile phone customers to TomTom as data collected by Vodafone can provide TomTom with information about traffic jams.

- The last pattern is **Codifying a distinctive service capability.** Through data and cloud computing (also discussed by Heppelmann and Porter (2014)) business' which have achieved best-in-class standards can sell the service to other business through cloud computing. For example, IBM developed a reporting systems for internal use, so efficient that they started selling it as a service to other businesses.

Another aspect is sustainability (Shrouf & Miragliotta 2015). Shrouf and Miragliotta (2015) stated that nowadays the market is demanding "green products", products which consumes a minimal amount of energy when used, as well as when produced. As products becomes equipped with sensors and communication technologies (Heppelmann & Porter 2014), it is possible to reach a sustainable manufacturing industry through the collection data (Shrouf & Miragliotta 2015; Heppelmann & Porter 2014). For example, research (Etzion & Aragon-Correa 2016) has shown that information can be used for triggering behavioural change. Only by presenting the information about resources consumption, manufacturers change their approach to sustainability and starts to optimize their processes to become eco-friendlier. It is all about Key Performance Indicators (KPI), CPS has made it possible to gather new types of data and it is therefore feasible to embrace new KPI's which not only focuses on economic aspects rather than environmental and sustainable aspects as well (Shrouf & Miragliotta 2015).

Furthermore, aligning with Heppelmann and Porter's (2014) levels of CPS utilization, Etzion and Aragon-Correa (2016) stated that through collection of data can processes be made efficient and optimized in real-time. Through real-time optimization of processes can energy efficiency be maximized, resource planning optimized, and the total environmental impact minimized. As data is collected at all time, from all processes and all products, real-time adjustments can be made to constantly strive for a more environmental efficient business (Etzion & Aragon-Correa 2016).

2.1.2. Discussion

The theories discussed in the above chapter provides an understanding for how smart products will contribute to the creation of value for businesses through the use of data. Parmar et al. (2014) and Barton and Court (2012) argues for that data-driven strategies and business models will be the main case of business development and that value-creation will increasingly be based on data. However, the literature above also shows a distinct segmentation on how to capture value. Barton and Court (2012), Cao et al. (2015), and McAfee and Brynjolfsson (2012) all focuses on how to capture the value of data for internal value creation. In this case the value of data presents itself with the opportunity to improve and optimize businesses existing business models and operational processes. Kolberg and Zühlke (2015) argues for the same thing, that the value of data erupting from Industry 4.0 mainly enables what they want to call "Lean automation", the possibilities to heighten a companies' lean work through digitalized solutions. Etzion and Aragon-Correa (2016) and Shrouf and Miragliotta (2015) both discussed the value of information in terms of internal optimization from a sustainable perspective. They argued for that the value of information also stretches out beyond economical aspects and provides the companies with means to strive for a more sustainable business.

However, even though there is an obvious value in an efficient decision-making process (Cao et al. 2015) and in the minimization of wasteful operations (Kolberg & Zühlke 2015), as well as in a minimized environmental impact (Shrouf & Miragliotta 2015; Etzion & Aragon-Correa 2016), newly conducted research (Ford 2015; Heppelmann & Porter 2014; Herterich et al. 2015; Koch et al. 2015; Mittermair 2015; Nathan 2015), do argue for that the real value of data is found in new sorts of data provided by the smart products and their CPS. It is this new types of data which opens up for new innovative business models which can capture and pass forward the real value of data (Heppelmann & Porter 2014; Herterich et al. 2015; Parmar et al. 2014). Further on, as Barton and Court (2012) stated, data-driven strategies will drive competitive differentiation, and the real chance of differentiation is found in new business models transforming data to value not yet found. The above section, describing the value of information in a digitalized era are therefore strengthening the validity of examine how CPS will drive business model innovation.

2.2. Business model

As emphasized in the introduction section, CPS will provide organizations with new data which until now was unobtainable. This data opens up for new innovative ways for creating value as well as it paves way for new, never thought of, collaborations both within and outside that specific industry. The term *Business Model* got its attention around the second millennium as the e-business and e-commerce exploded, but it became more of a buzzword and the business model approach was considered dead as the dotcom bubble burst (Osterwalder 2004). However, the development of businesses and value-creation can be traced back way further. The research on economics and value-creation can be traced back to the 19th century. The definition of value was at that time that it was embedded in matter, through manufacturing (Vargo & Lusch 2004). Later on, in the middle of the 20th century a new business approach started to develop, the service-dominant logic (ibid.). As stated in the introduction a lot of the value-creating opportunities deriving from the use of CPS are emerging around services. Therefore, this section will introduce the reader to the service-dominant logic and service-innovation before moving on to the actual business model.

2.2.1. Service-dominant logic and innovation

As Fischer et al. (2014) states, the business environment of manufacturing firms has changed dramatically over the last decade. Product innovation, development of technologies, and a constant pressure for minimizing time to market conceives a substantial part of a firms' investments (ibid.). However, Fischer et al. (2014) emphasized that many industries has reached a competitive equality which means that the product itself as competitive advantage is not a feasible strategy. This brought a new focus for manufacturing firms'. According to Fischer et al. (2014) manufacturing firms are nowadays selling their products with almost no margins or profitability and instead focuses on reaching an "installed base" of customers i.e. the market share which are using their products. To this installed base can the manufacturer thereafter provide services

(ibid.). Se figure (1) for the transformation from a product manufacturer into a service provider.

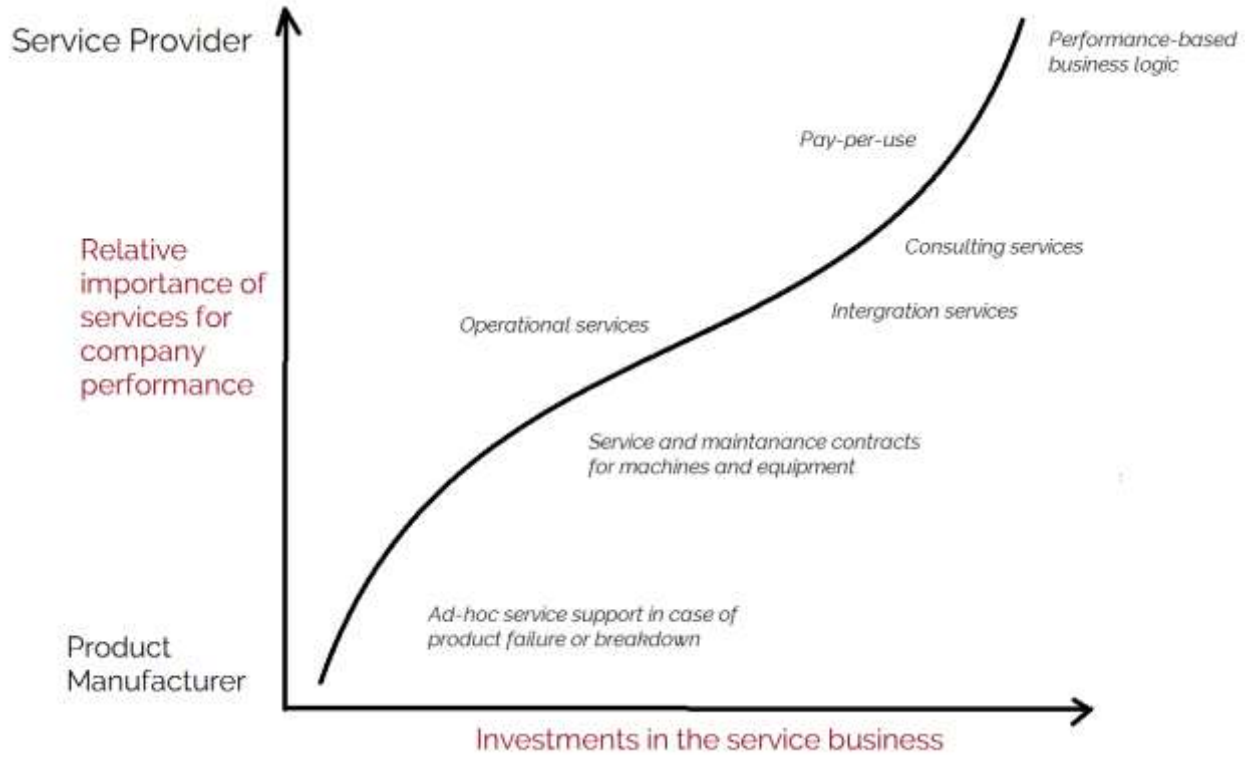

Figure 1: Moving from a product-dominant logic to a service-dominant logic freely revised from Fischer et al. (2014)

The service-dominant logic was first mentioned by Vargo and Lusch (2004) as they saw a new dominant logic for marketing emerging separately from the traditional product-dominant logic (or goods-dominant logic). It started with a change to how companies created value (ibid.). In the product-dominant logic value was embedded in matter through the process of manufacturing, the focus was on *operand resources*, i.e. resources which were operated *on* to increase its value. However, as more and more scholars started discussing value in terms of *operant resources* i.e. when an employee acts on operand resources it becomes clear that the most important resources were skills and knowledges (ibid.). This is the fundamental aspect of the service-dominant logic i.e. that the value is not the product itself rather than the service made possible through the product (ibid.).

Furthermore, the second most important difference between the product-dominant and the service-dominant logic is the view on relationships. The product-dominant logic is based on a two partaker relationship with a dominant part (the producer) which provides value through goods, to a passive recipient (the customer) (Lusch & Nambisan 2015). Instead, in the service-dominant

logic the focus is put on collaboration through the value-chain (Vargo & Lusch 2008) and networks of actors (Lusch & Nambisan 2015). In 2008, Vargo and Lusch presented a definition of the nine foundational aspects of the service-dominant logic. These were:

1. **Service is the fundamental basis of exchange,** as people specialize themselves in different skills the real exchange is not in tangible products rather than in specific skills one possesses.

2. **Indirect exchange masks the fundamental basis of exchange,** as the industrial revolution began skills were divided into processes. This created micro-specialists which organizations then gathered to complete, and optimize their production processes, thereby was their skills masked.

3. **Goods are distribution mechanisms for service provision,** as early as back in the 1940s Norris (1941 referenced in Vargo & Lusch 2004) stated that customers bought the product for the service provided by it.

4. **Operant resources are the fundamental source of competitive advantages,** the ability to learn and change drives competition. As knowledge is considered an operant resource and the right knowledge is a competitive advantage, operant resources is the source of competitive advantage.

5. **All economies are service economies,** however economic activities are defined, the true activity is the exchange of operant resources.

6. **The customer is always a co-creator of value,** as the value of services are in usage, and the service is produced and consumed at the same time, in a relationship between producer and customer; a service is always co-created.

7. **The enterprise cannot deliver value, but only offer value propositions,** enterprises can only offer a value-creation process to the customers. The value must be created collaborative after acceptance from the customer.

8. **A service-centred view is inherently customer oriented and relational,** as services are created collaborative, the service-dominant logic focuses on relationships.

9. **Organizations exists to integrate and transform micro-specialized competences into complex services that are demanded in the marketplace,** Developed from the above eight aspects a ninth derived. If all above aspects are put together, the fundamental reason for organizations existence is to combine operant resources to provide services.

As mentioned by Fischer et al. (2014), manufacturing industries are transcending towards becoming service providers as their products have reached competitive equality. Forthcoming from this change is that the competitive advantage, earlier embedded in products, is now found in the service-innovation process (Fischer et al. 2014; Lusch & Nambisan 2015). Lusch and Nambisan (2015) developed four elemental aspects of service innovation. They emphasized on the network approach and that there is no producer/customer relationship rather than a network of *actors*. To benefit from the network of actors, *resource liquefaction* is of importance i.e. the ability of separating information from their physical relative. When the information has been decoupled from its physical object the need to mobilize and analyse the information is at hand, the effectiveness and efficiency of this process is what Lusch and Nambisan (2015) states as *resources density*. Further on, when innovating services, information and data is gathered (resource liquefaction) and then analysed and mobilized (resource density) and by working in the network of actors resources can be integrated, which is the fourth aspect, *resources integration*. Lusch and Nambisan (2015) argues for that all service innovation is the result of combining existing resources in new ways.

2.2.2. Business model innovation

Osterwalder (2004) was one of the first scientists whom conducted research on the "modern" business model approach. The term *Business Model* became a buzzword together with the development of internet based businesses (ibid.). However, as Osterwalder points out in his doctoral thesis, after the burst of the IT bubble the term "business model" was considered dead. Although, Osterwalder decided to continue with his research. Therefore, it is considered valid to see his research as one of the firsts on *modern* business models. Moreover, Osterwalder (2004) emphasized that, at that time, no tools or direct concepts for describing a company's business model existed. This led to the development of the *Business Model Canvas* (BMC) which Osterwalder developed together with Pigneur (Osterwalder & Pigneur 2013).

In the vaguest definition of a business model, Osterwalder (2004 p.16) stated that a business model *"is a conceptualization of the money earning logic of a firm"*. Chesbrough (2010) stated that it is through a company's business model new ideas and technologies are commercialized and that the business model is of more importance than the product or service provided. Chesbrough (2010) argued for that a mediocre product/service with a great business model will be more successful than a great product/service coupled with a mediocre business model. Furthermore, as the development of the BMC took place, the definition of a business model transformed i.e. to a definition more fit to today's businesses and business-logics. Osterwalder and Pigneur (2013) defined the business model as *"A business model describes the rationale of how an organization creates, delivers, and captures value"*.

Moreover, as Osterwalder (2004) started the research on the modern term, and use of, business models, and later on developed the BMC together with Pigneur (2013) it is validated to consider the BMC as the main framework for discussing business model innovation. However, there is other tools for business model generation as well, such as the IBM's component business model (Phole et al. 2005) and Lean Canvas (Maurya 2010), which both will be shortly described after the BMC to elevate the understanding for business model innovation.

2.2.3. Business Model Canvas

In its foundation, the BMC attacks four areas of strategy when doing business; *Value proposition*, *Infrastructure*, *Customers*, and *Finances* (Osterwalder & Pigneur 2013). To provide a clear and understandable description of a business model Osterwalder and Pigneur (2013) divided the concept of a business model into nine building blocks. These nine building blocks were (Osterwalder & Pigneur 2013):

Customer Segments: The first question which a business need to ask themselves is; "*For whom are we creating value?*". Customers are the fundamental aspect of a sustainable business and the most important decision a business is going to make is for whom they are creating value. To better understand the market the company divides the market into segments. The company then target the customer segment they think fit to their operation.

Value proposition: A business' value proposition is the combination of goods and services provided by the company. It is the value proposition which mainly differentiate the company from its competitors. Osterwalder and Pigneur (2013) defines two characteristics of a value proposition, either it is of a quantitative nature e.g. price and accessibility or it is of a qualitative nature e.g. functions, design, etc. However, independent of the characteristics, the purpose is always to fulfil the chosen customer segments' needs, i.e. solve a problem specific for that chosen segment. The value proposition can be as fundamental as lower price than competitors, or as complex as customization and customer co-creation, which has achieved increased focus in the subject of value creation as it aligns with the growing service-dominant logic (Vargo & Lusch 2008).

When the value proposition is established together with which customer segment the company are targeting the channels for distribution and the relationships toward the customers, this will complete the Business models external aspects, see figure (2).

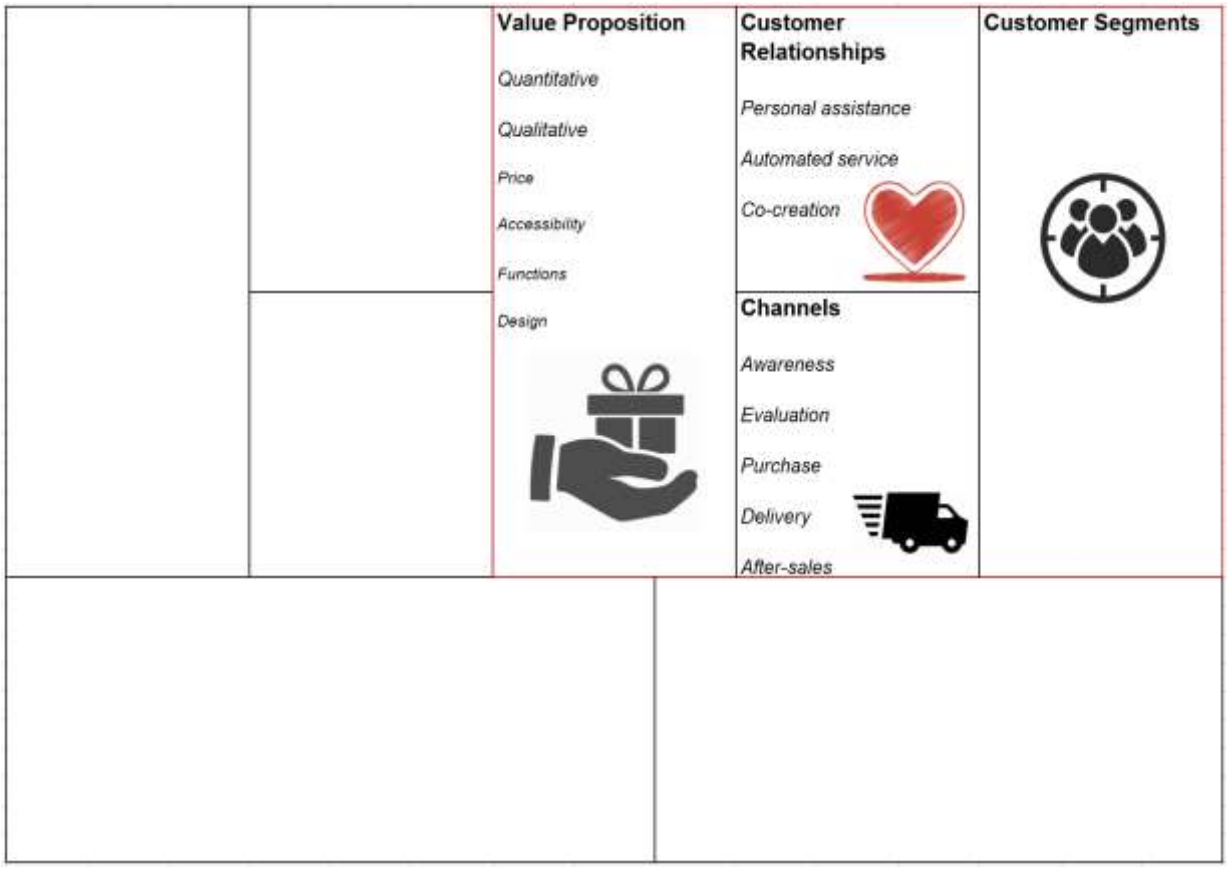

Figure 2: The first four blocks of the BMC, the external building blocks freely revised from Osterwalder and Pigneur (2013).

Channels: This part of the BMC is developed to define how a business is communicating with their customers, how their value proposition is distributed and how sales are made. There are five impending goals for the company regarding their channels which are coupled to specific phases of the use of channels, these are:

1. **Awareness**: The first phase is by Osterwalder and Pigneur (2013) defined as using channels to make the customers notice the company's existence and their value proposition.

2. **Evaluation**: Secondly, the channels should provide the needs for evaluation. The company must provide the customer with necessary information, making it possible to review the organizations value proposition and compare it to competitors.

3. **Purchase**: The third phase is how to make it possible for customers to purchase the company's products and services.

4. **Deliver**: The second last phase coupled to channels are how to deliver the value proposition.

5. **After-sale:** The last utilization of channels is coupled to the after-sales market. Here should the company state how after-sales services and support are provided and especially through which channels. To be noted is that in a service-dominant logic, services are the foundation of the business model. However, after-sales are, in the BMC, categorized under *distributions channels* and relates more to the distribution of services then the services itself. In a service-dominant business will services be the main value proposition and after-sales will be more related to how distribution should be handled.

Customer relationships: Osterwalder and Pigneur (2013) emphasized on the importance of this block as the approach to customer relationships will heavily affect how customers perceive the company. Furthermore, the relationship between the company and the customers are highly affected by the underlying goals of the company e.g. if the company wants to acquire more customers, more focus will be on marketing and a shallow relationship. However, if the purpose of the relationship is to preserve their already established customer base focus will be on personal assistance, nursing every customer specifically.

Revenue streams: When a company has established their value proposition and how to reach out to their decided customer segment, they need to establish how they are going to charge their customer for benefitting from their value proposition. The important questions here are, "What are the customers willing to pay?" and "How does the customer want to pay?". Furthermore, the pricing can be done both dynamic (e.g. when negotiating) or stationary (e.g. the price is coupled to the volume bought).

Next of in the business canvas model is the internal building blocks; *Key resources*, *Key activities*, and *Key partnership*, see figure (3).

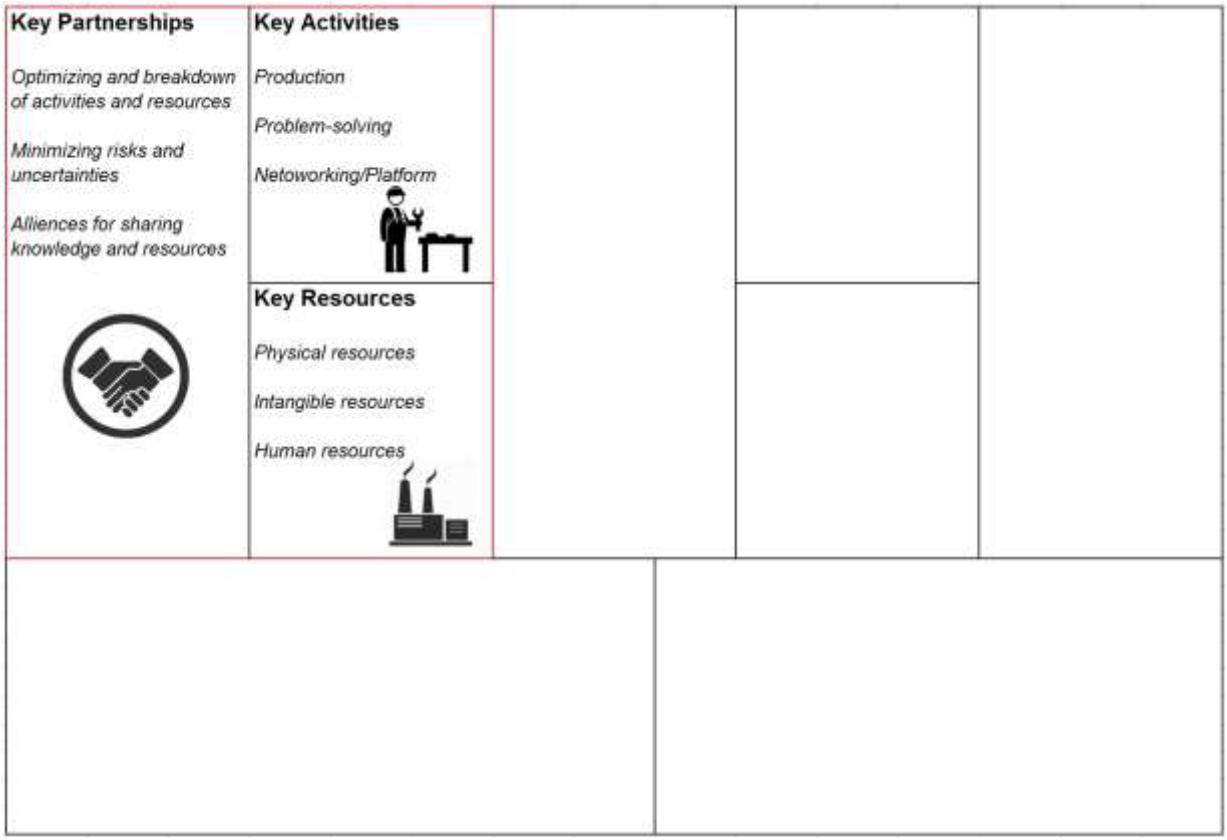

Figure 3: The three internal blocks of the BMC freely revised from Osterwalder and Pigneur (2013).

Key resources: There are different types of resources which all can be key resources depending on the business model. *Physical resources* are such resources as production sites and machines and are the key resources for companies selling tangible products. Customer databases, Trademarks, and knowledge are examples of *Intangible resources*, these are difficult to create but ones they are developed they will most likely be of significant value to the company.

Human resources is important for all companies, as staff, however, for knowledge-intense and creative industries e.g. in consultant firms, are the employees the key resource.

Key activities: This building block regards a company's key activities i.e. those activities which needs to be performed to make the business model work. *Production* is the key activity for companies focusing on selling tangible products, these companies needs to design, manufacture and deliver tangible products in a large scale for their business model to work. *Problem solving* is another key activity highly coupled with hospitals and consultants as example, their business model will in most cases state knowledge as *key resources* and their business model would not be beneficial if this knowledge (key resource) was not utilized through the right key activities i.e. problem solving. *Networking* activities is the last type of key activities defined by Osterwalder and Pigneur (2013). Some business models are based on networking and platforms, e.g. Microsoft needs to maintain and continuously develop their platform, Microsoft Windows, to ensure that their business model is valid.

Key partners: Sometimes, to make a business model work, specific partnerships need to be established. Osterwalder and Pigneur (2013) defines three reasons for establishing partnerships. The most fundamental alliance is between supplier and customer and is based on the aim of optimizing and dividing activities and resources. Another type of partnership is based on the minimization of risks and uncertainty e.g. in very competitive markets, partnerships may be developed in specific areas to minimize risks. The last type of partnership is alliances formed to share knowledge, licenses and other resources. These types of alliances are best described with an example from the telecom industries. A mobile producer may collaborate with a company developing operating systems instead of developing their own.

The remaining building block is the *cost structure*. Even though cost structure and revenue streams in one aspect are appendage to the business model as whole, some businesses focus more on them than others. However, there is of course important to break even as the economic side of a business model is what makes it works in the long run.

Cost structure: The last building block of the BMC is the cost structure. This block describes the most important costs associated with the specific business model. If key activities and key resources is established and deeply rooted to the business' operations the cost structure should not be hard to establish either.

Osterwalder and Pigneur (2013) divided costs into; *Fixed costs*, *Variable costs*, *economics of scale*, and *economics of scope*. Further on, some business models are heavily dependent on the cost structure i.e. those businesses focusing on minimizing costs, cost-driven businesses. Others, those specifying themselves as value-driven puts less focus on the cost structure as it is considered more of a "necessary" evil when creating and capturing their value proposition.

All these nine building blocks can be seen in figure (4).

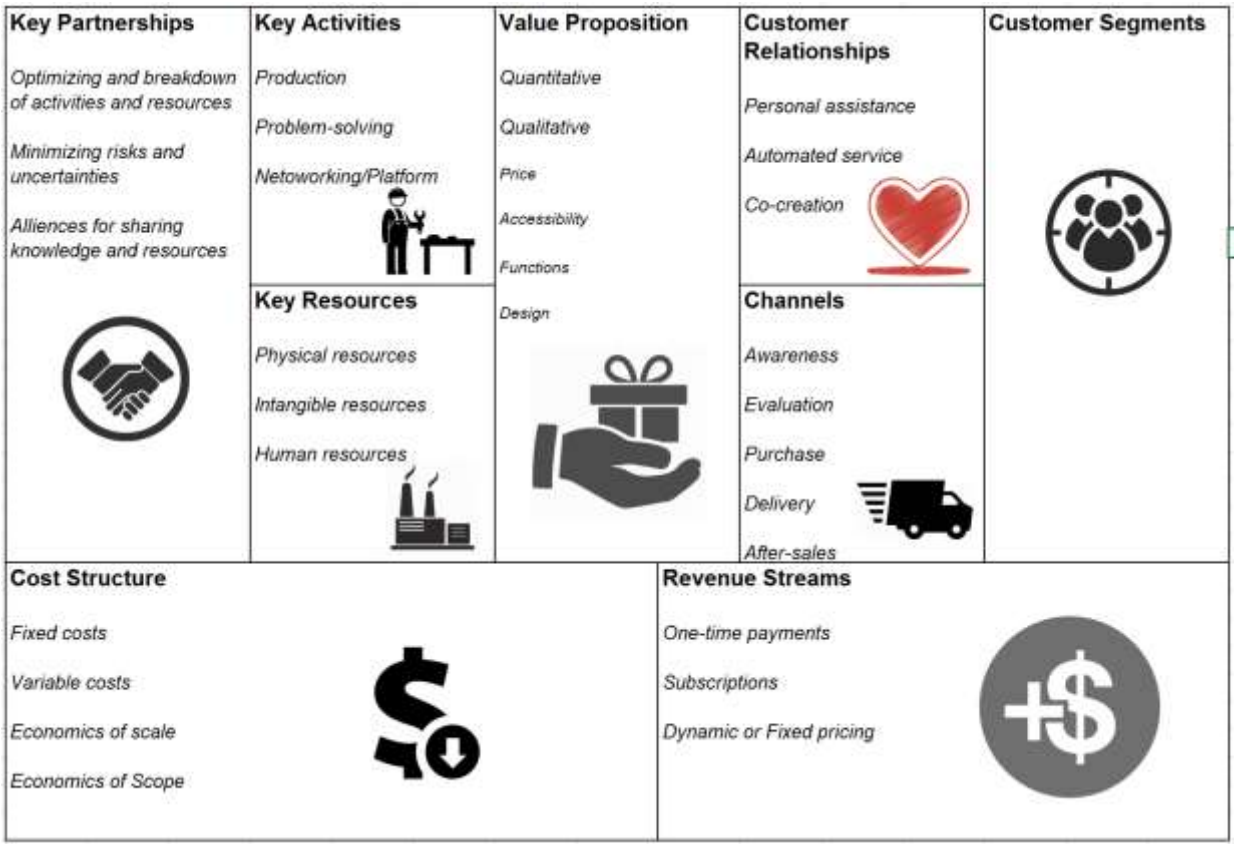

Figure 4: The Business Model Canvas freely revised from Osterwalder and Pigneur (2013)

As briefly mentioned above, there are external and internal organizational aspects of the business model. However, Osterwalder and Pigneur (2013) defines it as organizational efficiency and value, where *Customer Segments, Channels, Customer relationships,* and *Revenue streams* are coupled to *value*. *Key partnerships, key activities, key resources,* and *Cost structure* are coupled to *efficiency*. The value proposition is the central part of the business model and weights in on both the value and the efficiency.

When searching for literature regarding business model generation and innovation, except the business model canvas, there were two more tools for innovation that came up i.e. the IBM Component Business Model (Phole et al. 2005) and the Lean Canvas (Maurya 2010), therefore will these two tools of business model innovation also be briefly discussed.

2.2.4. Alternatives to the BMC

IBM Component Business Model

Chesbrough (2010), as mentioned above, stated that a business model is a company's tool for commercializing an idea. Chesbrough (2010) do acknowledge Osterwalders (2004; 2013) nine building blocks of a business model which later turned into the BMC. However, Chesbrough (2010) focused on another tool, the IBM Component Business Model (CBM) as he emphasized that IBM early on adopted this kind of thinking regarding business models. Chesbrough (2010) argues for the use of the CBM as it enables the company to simulate various possibilities before committing to the investments which opens up for an experimental approach based on trial-and-error.

It was Phole et al. (2005) that developed the CBM. The purpose of the CBM was to help businesses specialize as IBM had recognized the value of specialization and diversification in a competitive aggressive market. The CBM provides a framework for transforming the business both externally and internally. Phole et al. (2005) states that there are three phases of external specialization, which starts with the *Internally integrated* firm. At this stage the focus is put on quality inputs and distribution and the ownership inside the value-chain is shattered. In phase two, *strategical partnerships* erupt and the specialization within the value-chain starts. In phase three, *Industry networked,* the firm is specialized on its core-activities and acts inside an ecosystem in which all contributes by their specialization to create value. Moreover, Phole et al. (2005) also described three stages of internal specialization. These three phases regards to which level the organization is optimized, where the first level only the different *business units* are optimized, followed by an optimization of the *Processes*. In the final phase of internal specialization, the whole enterprise is optimized with a centralization of finance, IT and HR-functions and a customer-oriented company, also, Phole et al. (2005) states that an internal specialized firm is closer to a service-dominant logic. The CBM can be seen in figure (5) (Chesbrough 2010). Each building block, or module as it is called, consists of five dimensions

which helps to define what that specific module contributes with to the business. These five dimensions are (Phole et al. 2005):

Business purpose: This dimension helps to define why this module is needed and how it *should* contribute to the business.

Activities: This dimension describes which activities that are performed on a regular basis to make this module work.

Resources: Which intangible and tangible resources are needed to make this module work.

Governance: How is this module managed.

Business services: All modules have some sort of impact on each other, this dimension describes how this particular module acts towards other modules as well as how they react from other modules.

The five dimensions can be seen in figure (6).

<table>
<tr><th></th><th>Business Administration</th><th>New Business Development</th><th>Relationship Management</th><th>Services and Sales</th><th>Product Fulfillment</th><th>Financial Control and Accounting</th></tr>
<tr><td>Direct</td><td>Business Planning</td><td>Sector Planning</td><td>Account Planning</td><td>Sales Planning</td><td>Fulfillment Planning</td><td>Portfolio Planning</td></tr>
<tr><td rowspan="2">Control</td><td>Business Unit Tracking</td><td>Sector Management</td><td>Relationship Management</td><td rowspan="2">Sales Managment</td><td rowspan="2">Fulfillment Management</td><td rowspan="2">Compliance reconciliation</td></tr>
<tr><td>Staff Appraisals</td><td>Product Management</td><td>Credit Assessment</td></tr>
<tr><td rowspan="3">Execute</td><td>Staff Administration</td><td>Product Delivery</td><td rowspan="3">Credit Administartion</td><td>Sales</td><td>Product Fulfillment</td><td>Customer Accounts</td></tr>
<tr><td rowspan="2">Product Administration</td><td rowspan="2">Marketing Campaigns</td><td>Customer Dialogue</td><td rowspan="2">Document Management</td><td rowspan="2">General Ledger</td></tr>
<tr><td>Contact Routing</td></tr>
</table>

Figure 5: IBM's Component Business Model freely revised from Chesbrough (2010)

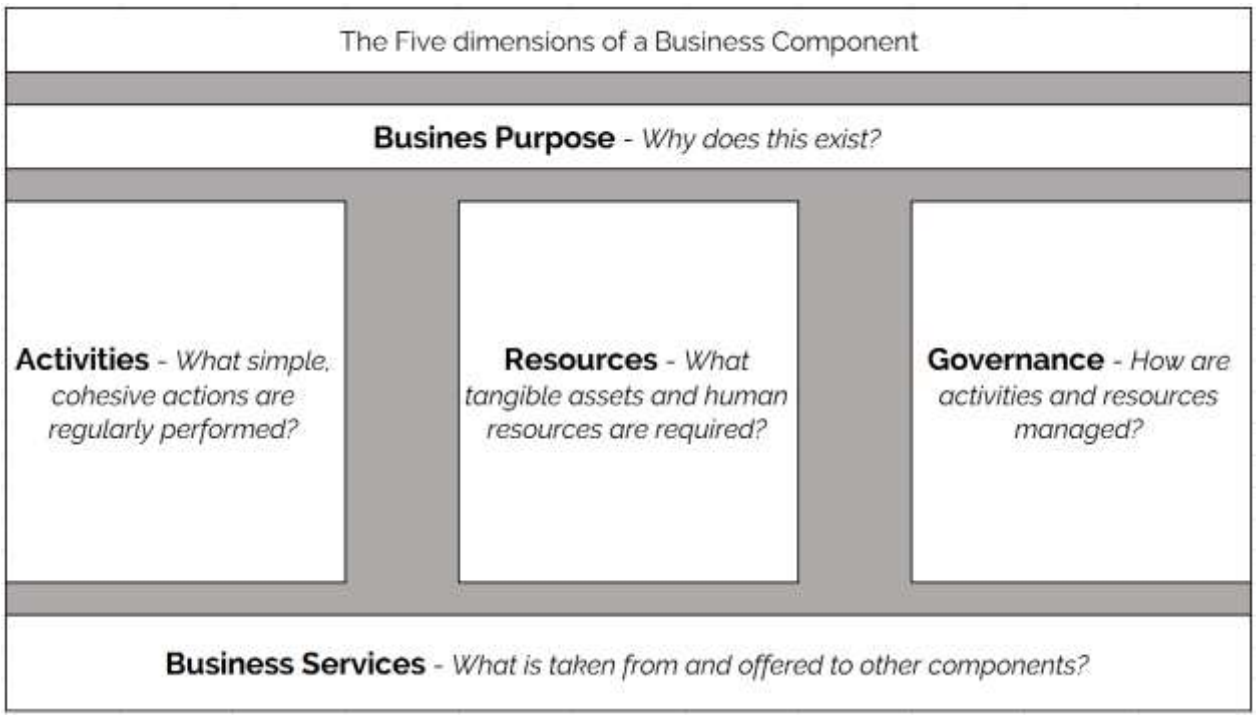

Figure 6: The five dimensions of each module in the CBM freely revised from Phole et al. (2005).

Lean Canvas

Maurya (2010) acknowledged the canvas approach to business model innovation as *Fast*, *Concise*, and *Portable*. However, Maurya (2010) thought that the BMC needed a remodelling to fit start-ups as he argued for that the business model innovation tool should be more focused on new companies as the real opportunity for innovation lies in start-ups. Furthermore, the Lean Canvas looks like the BMC and do also consist of nine building blocks (ibid.). However, some parts of it is remodelled to fit Maurya's (2010) ambitions. The Lean Canvas consist of nine building blocks but are built in seven steps as Maurya (2010) argued for that some parts need to be evaluated together, or alternatively, towards each other. The Lean Canvas are shown in Figure (7). The description of each part can be found below.

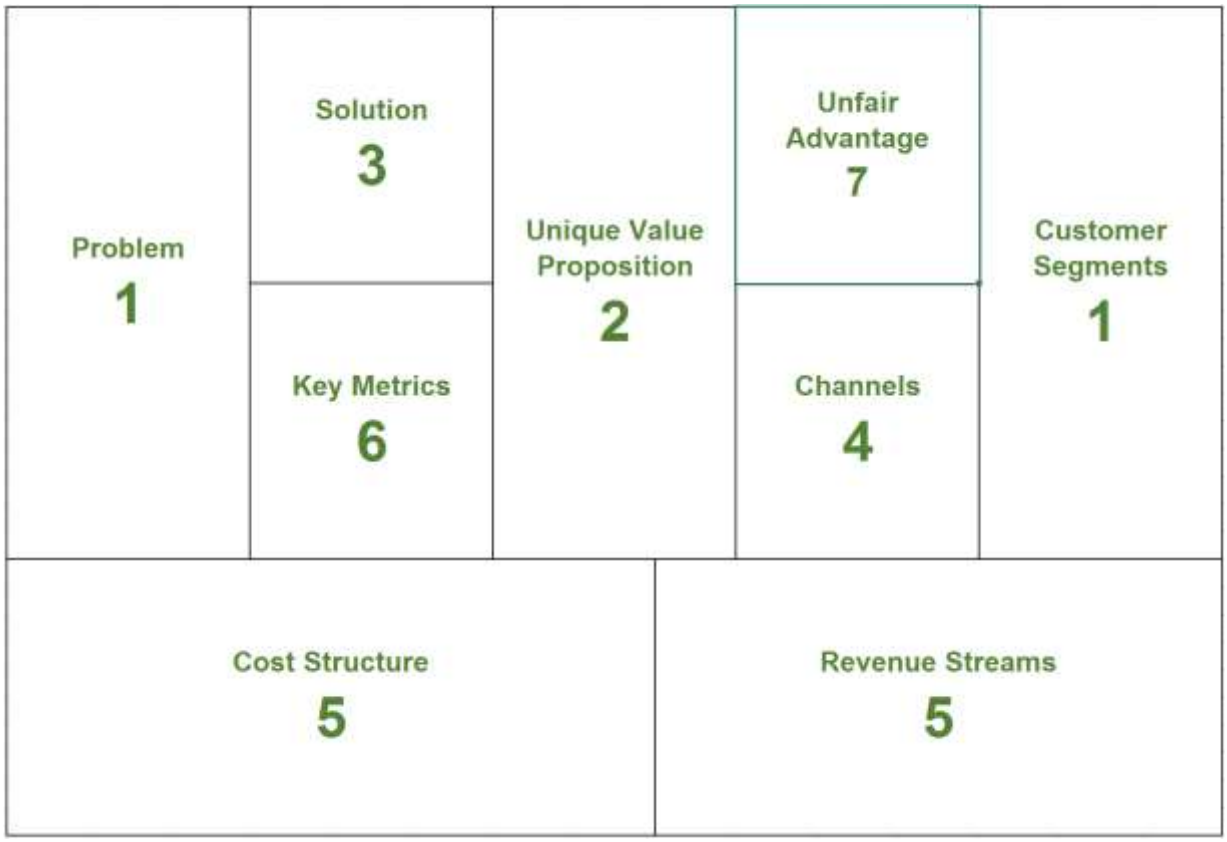

Figure 7: The Lean Canvas revised from Maurya (2010).

Problem and ***Customer Segments:*** These two blocks are worked with together as a problem almost always also refers to a specific customer segment. Therefore, the Lean canvas starts with the problem and for whom the problem is current.

Unique Value Proposition:. The company's unique value proposition is what makes the company's value worth buying. It is what makes the company better than the next competitor.

Solution: When a business' competitive advantage is determined (the value proposition) it is time to connect the problems with the solutions, through the value proposition.

Channels: Different solutions and problems may only fit to specific channels. It is therefore highly recommended to find the path to the customers early on.

Revenue streams and ***Cost structure:*** As the goal is to find a viable business model for a new innovative solution to existing problems, revenue streams and cost structures needs to be examined together. The pricing is part of the product and the product must validate the pricing, at the same time, the revenue streams

must fit to the solution, customer segment, and also it must align with the cost structure to make the business model valid.

Key Metrics: As start-ups very often is an uncertain and chaotic journey the key activities and metrics needs to be established as it provides the necessary overlook of the business.

Unfair Advantages: *"E*verything which is worth copying will be copied". This means that in this block, the unfair advantages should be stated, something which is hard to copy and/or cannot be bought, something which gives this specific company and business model an advantage towards competitors.

2.2.5. Discussion

After examining the three above stated tools for business model innovation it is clear that the BMC is best of choice as framework for this study. However, the BMC is not the concept studied in this thesis, it is merely embraced as a framework describing which aspects of a business model which needs to be established. Moreover, the CBM has its advantages for an established business model which needs optimization. The focus of the CBM is to optimize the current business model and/or generate a new business model based on specialization (Phole et al. 2005). Furthermore, even though the external specialization phases showed a move towards the network approach (Lusch & Nambisan 2015) there is no specific thoughts put on how to create and capture value, channels for value distribution, or partnership in the meaning of data utilization and leverage as proven a central part of Industry 4.0 (Ford 2015; Heppelmann & Porter 2014; Herterich et al. 2015; Koch et al. 2015; Mittermair 2015; Nathan 2015). The Lean Canvas, is also ruled out since even though the problem/solution approach fits the development of business models leveraging data in new ways, it is to focused on start-ups. Industry 4.0 and CPS opens up for new possibilities and capabilities regarding the utilization of data, which means for this study the BMC is most fitting as it aligns with the goal of business model innovation both for start-ups *and* for existing businesses trying to evolve and embrace the smart, digitalized manufacturing industry. Furthermore, as discussed in the section *Smart products and value-creation through data*, the utilization of CPS and data will heavily affect the value proposition as new ways to capture and create value emerges. Moreover, both in the section *Smart products and value-creation through data* and the section *Service-dominant logic and innovation* it is clearly stated that CPS and the use of data will open up new channels for distributing value, new ways to cooperate cross-organizational, new customer relationships,

and new revenue streams, all of which is a perfect fit with the BMC (Osterwalder & Pigneur 2013). Moreover, the concept of business models are in this thesis approach from the CPS point-of-view. This means that some aspects of the business model may be more discussed than others. If a similar study is conducted, but with its foundation in business models, other aspects may be in focus.

2.3. Cyber-physical systems

As established in the introduction section, Industry 4.0 is in its foundation about data, data which is becoming available through CPS. Therefore, the questions raised in this study is how these CPS will affect business models generation and to understand the impact of CPS, an understanding for CPS itself is needed. Thus is this section introduced with the aim of explaining CPS.

2.3.1. Definition and Characteristics

The term *Cyber-Physical Systems* was first coined by Lee (2006) and he defined CPS as "*integrations of computation with physical processes"*. Wang et al. (2015) further elaborated on that definition and stated that CPS are:

> "Embedded computers and networks which monitor and control the physical processes, usually with feedback lops where physical processes affect computations and vice versa."

Moreover, it is clearly stated (Lee 2006; Lee et al. 2015; Wang et al. 2015) that the integration of computation and physical processes has been around for a while. However, the term used then was "Embedded systems" and the most fundamental characteristic of an embedded systems is that it was a closed system which not communicated with outside systems i.e. both physical and/or computational (Lee 2006; Lee et al. 2015; Wang et al. 2015). Furthermore, along with the development of networking capabilities and the continuously development of communication technologies which has become both more advanced, smaller, and cheaper those closed embedded systems (Lee 2006) has transformed into CPS, connected and more advanced embedded systems (Wang et al. 2015; Lee et al. 2015; Lee 2006). In figure (8) a concept map of CPS is shown, developed by Sunder et al. (2012).

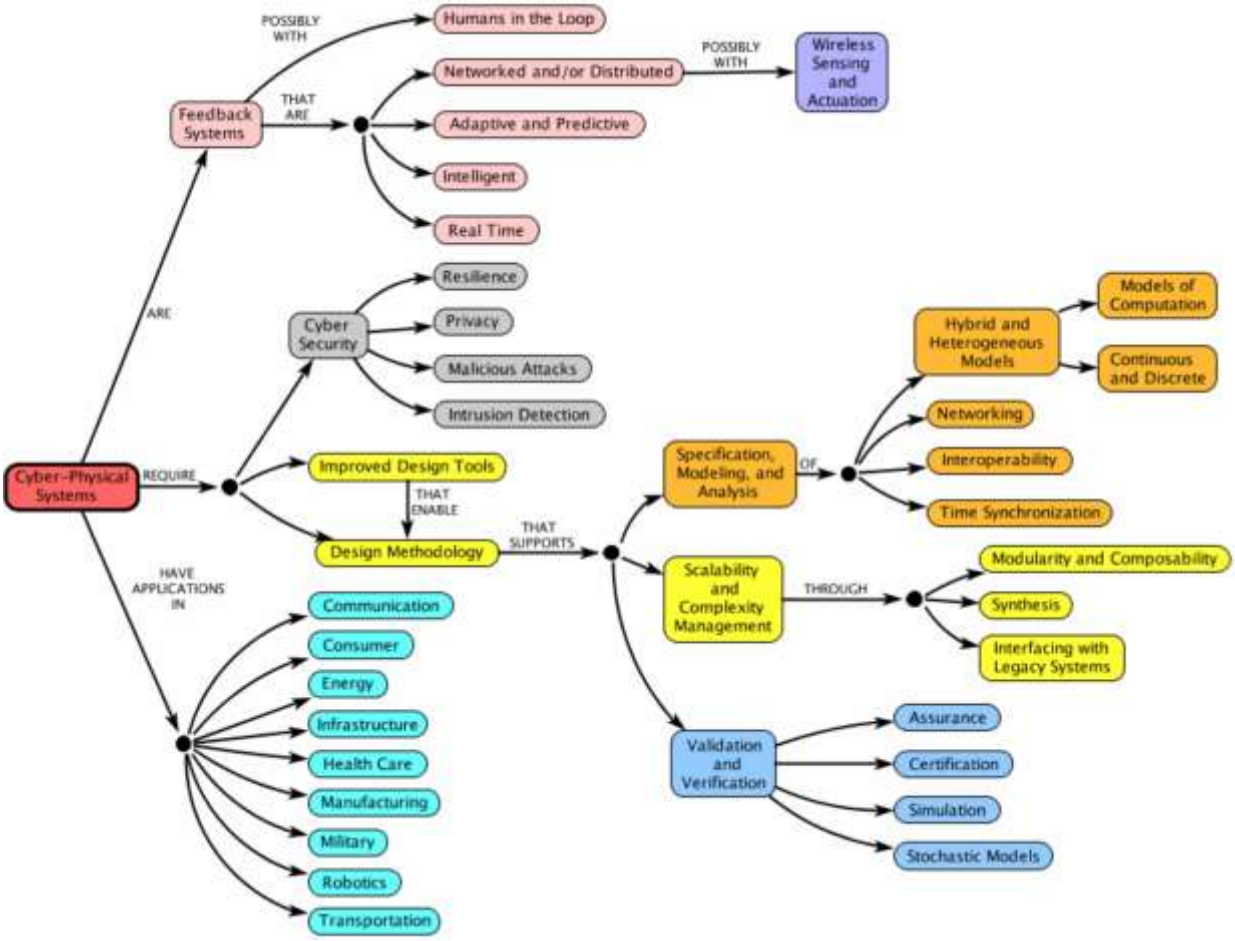

Figure 8: A Concept Map of Cyber-Physical Systems, taken from http://cyberphysicalsystems.org/ (Sunder et al. 2012)

Moreover, as mentioned, CPS are the future of embedded systems. Wang et al. (2015) presented ten characteristics of the CPS-advancement to come. These characteristics are introduced below in the order of which these design choices have to be made.

A CPS is either *Deeply embedded,* with the functionality and the value embedded; or it is *IT dominated* focused on communication with the functionality online. CPS consists of either a *single-domain* or *cross-domains* characterising how much functions it includes. Even though the definition of CPS states that it is embedded systems *communicating* (Lee 2006), some CPS may deliberative be *closed*, however, the most benefits of CPS contra traditional embedded systems, is the possibility of *openness*. Further on, design choices have to be made regarding which degree of *autonomy* that is wishful, the level of *human involvement* needed and the *level of integration* wanted. Last, design choices will decide how the system is *governed, controlled,* and how *jurisdictions* are handled. (Wang et al. 2015)

Lee et al. (2015) developed an CPS architecture for Industry 4.0-based manufacturing and how to implement CPS into the factory. Lee et al. (2015) called this their *5C architecture* and the aim was to introduce and define a sequential workflow for the construction of CPS.

Smart ***Connection*** is the first C in Lee et al. (2015) architecture and defines that CPS should start in the acquiring of data from machines and their components. Either the data comes from external systems, such as ERP or MES systems, or it is gathered directly via sensors and such.

Data-to-information ***Conversion*** is the second C and states that the data gathered needs to be interpreted to useful information.

Cyber is the third level in Lee et al. (2015) 5C architecture and it acts as a hub for all information. All data, from all connected machines, ends up in the cyber level where it is analysed to provide insight and understanding for all the machines status and condition.

Cognition, the fourth level, approaches the benefits gained when making decisions. The fourth C is about presentation i.e. a proper presentation of acquired information and knowledge to experts and decision-makers will elevate the decision-making process and optimize the organization processes.

Configuration is the last C and represent the feedback loop. When CPS is utilized throughout the whole organization, information and knowledge gained can be fed back from the cyber space into the physical space and act as a controlling unit, this control, based on data gathered from all over the organization will make the physical plane both self-configure and self-adaptive.

As mentioned above, CPS is actually a new term describing embedded systems with the ability of networking (Lee 2006; Lee et al. 2015; Wang et al. 2015). Thus is the next section dedicated to the description and presentation of *embedded systems* and how they work.

2.3.2. Embedded Systems

What is an embedded system? Lee and Seshia (2015) explains it like this; Humans interacts with computers every day, those "visible" computers and software's are developed and produced for the purpose of processing and presenting information for human consumption. However, those computers and systems is only a very small part of all computational systems in use around the world. The most used computers are those humans do not interact directly

with, systems which control robots in a production line or power generation at a power plant, these computational systems are called *embedded system*. Embedded systems have been used since the 1970s and the limited utilization of them comes from the problem of limited resources. However, as technology advanced these embedded systems were optimized and also equipped with communication devices and were after that to be called CPS, and with that transformation the understanding where also elevated, there is now no problem with the limitation of resources, the problem lies with the degree of integration between computational systems and physical processes. (Lee & Seshia 2015)

2.3.3. Benefits and drawbacks

The benefits of utilizing CPS is presented through the availability of data, discussed in the earlier section *Smart products and value-creation through data* but what is the problems and drawbacks with CPS?

There are two types of problems regarding the utilization of CPS, one is the indirect problems erupting from usage, problems which needs to be fixed before the true potential of CPS can be reached. The other type is direct problems, problems which inhibits the development and spreading of CPS. However, the focus of this thesis is not CPS itself rather than its impact on business models and therefore will this section be kept short and to the point only to provide the reader with an understanding for the problems related to CPS.

The first and foremost indirect problem is the one coupled to the buzzword "*Big Data*" (Wang et al. 2015). CPS enables a huge amount of data to be gathered, which also is the purpose of utilizing CPS, however, this demands new advanced and efficient tools for conducting analysis, otherwise there will not be possible to benefit from all data made available (Wang et al. 2015). The direct problem is regarding security (Heppelmann & Porter 2014; Herterich et al. 2015; Koch et al. 2015; Lee et al. 2015; Wang et al. 2015). True data leverage includes transparency and openness, but information is not to be shared to everyone, and as everything becomes connected and put online, the threat of information stealing is at hand and with every detail/product/machine joining the network the threat increases. The question of security must therefore be solved before CPS can break-through (Wang et al. 2015).

2.3.4. Discussion

As stated earlier, this thesis is not conducted with the purpose of examine CPS in depth. The aim of the study is to understand how business models should be developed to embrace the capabilities coupled to CPS, however, with that said; A foundational understanding of CPS is needed to embrace the findings and elevate the knowledge achieved from this study.

First and foremost, CPS is not a new technology per say rather than known technologies and concepts i.e. embedded systems, which evolved into CPS by advancements in technologies and the introduction of communication (networking) technologies (Lee & Seshia 2015; Lee et al. 2015; Wang et al. 2015). The five C's of an implementing architecture regarding CPS and Industry 4.0 (Lee et al. 2015) will be used when analysing the empirical data of this study as it will provide the necessary explanation of how far a company has come in the utilization and implementation of CPS.

2.4. Theoretical framework and additional research questions

In this section will the theoretical framework embraced throughout this study be introduced. The framework is divided into three parts, or themes, emerging from the theories introduced in earlier sections.

2.4.1. Smart products and the value of information

Herterich et al. (2015) stated that with the introduction of smart products, more data and new types of data will become available in real time. Heppelmann and Porter (2014) defined four possible utilization areas for data. These were;

- ***Monitoring:*** Smart products can be monitored when used, providing data which helps maintenance understand possible problems or it helps the design team to optimize and improve the product based on usage.
- ***Controlling:*** As embedded systems now also is equipped with network capabilities (CPS) smart products can be remotely controlled.
- ***Optimization:*** When monitoring and remote controlling is combined the rich amount of data together with the possibility to remotely control the product a new level of optimization can be achieved.

- ***Automatization:*** If all three above stated levels are utilized a new level of automatization can be reached. The enormous amount of data makes it possible to automate the decision-making process which opens up for what Mittermair (2015) said to be the "Automation of Automation".

The above stated levels of data utilization will be used as the reference frame describing what the value of information is and how data provides value for an organization.

2.4.2. The Business Model

Fischer et al. (2014) emphasized on the fact that there is a transition in business models going on. Manufacturing firms are moving towards a service-dominant logic (ibid.). Further on, the service-dominant logic consists of two major differences compared to the traditional goods-dominant logic. These were, first, that value derives from operant resources, i.e. the value is not the product itself rather than the service made possible through the product (Vargo & Lusch 2008). Secondly, in a service-dominant logic focus lies on collaboration throughout a value-chain instead of inside an organization (Lusch & Nambisan 2015).

For this study, the business model canvas was chosen as theoretical framework based upon that Osterwalder in his doctoral thesis states that the term *business model* was considered dead as the IT bubble burst but decided to continue with his research anyway (Osterwalder 2004). From that research, the BMC later on emerged (Osterwalder & Pigneur 2013) and therefore is the BMC considered valid as a description of what needs to be included in a business model (see the nine characteristics of a business model in figure 4).

2.4.3. *Cyber-Physical Systems*

Lee (2006) defined CPS as "*Integrations of computational with physical processes"* and on a more technical level CPS is embedded computational systems equipped with network capabilities (Lee 2006; Lee & Seshia 2015; Wang et al. 2015). Lee et al. (2015) developed a five level architecture for implementing CPS in an Industry 4.0 manufacturing firm, this architecture will be used as the theoretical framework for this study regarding CPS:

- ***Connection:*** The first utilization of CPS is in data collection.
- ***Conversion:*** When data is collected, the right interpretation is needed to shift *big data* into *smart data.*
- ***Cyber:*** This level represents the network capabilities and acts as a hub for all information.
- ***Cognition:*** The fourth level is about presentation, when data has been interpreted, it needs to be presented to the decision makers in a clear way.
- ***Configuration:*** Represents the feedback loop. When a CPS is fully utilized the information is used for autonomous decisions and the information is later looped back to the machines making them self-configurative and self-adaptive.

2.4.4. Research questions

The aim of this thesis is to understand how business models are affected by Cyber-Physical Systems. Deriving from this aim, the following research questions are identified:

> **RQ_1:** *What impact will Cyber-Physical Systems have on business models?*
>
> **RQ_2:** *How should business models be generated and/or developed to include the benefits of Cyber-Physical Systems?*

However, more specific research questions have risen from the literature study; First off, as both Herterich et al. (2015) and Heppelmann and Porter (2014) argues for that with the ability to collect and analyse data in real time huge possibilities arise and a fundamental change in business models will be unavoidable. In the BMC is the value proposition at centre (Osterwalder & Pigneur 2013), therefore do another important question arise:

> **RQ_3:** *How will Cyber-physical systems change the value proposition?*

Moreover, aligning with the service-dominant logic, Lusch and Nambisan (2015) argues for that the market consists of a network of actors. The fundamental definition of Industry 4.0 also states that it is about creating value throughout the whole value-chain (Plattform Industrie 4.0 2014). This shows that the network approach is very important when discussion the future of manufacturing industries and as the BMC includes the building stone *key partnerships* (Osterwalder & Pigneur 2013), another question emerges from this topic:

RQ4: *How will Cyber-physical systems change key partnerships?*

3. Methodology

This section was developed with the purpose of describing and motivating the methods used throughout the thesis. The section starts with a presentation of the research purpose, followed by chosen research strategy and research design. Further on, the research process is introduced with an in-depth walk-through of interviews, sampling, and analyse method. The section ends with a discussion regarding the thesis trustworthiness.

3.1. Research purpose

Saunders et al. (2009) discussed three different purposes for a study, these were: *Explorative*, *Descriptive*, and *Explanatory* purposes. This thesis had an overall aim of "*understanding how business models are affected by the utilization of CPS"* a clear explorative purpose. An explorative research approach is to prefer when the problem is somewhat unclear and the ambition of the study is to elevate the understanding of a problem (ibid.), i.e. which impact CPS will have on business models. Further on, Saunders et al. (2009) listed three typical ways for conducting such research, these were; through *literature reviews*, by *interviewing* experts on the subject, and by conducting *focus groups interviews*.

However, to fully understand how business models are affected by CPS, the object of this thesis was also to provide pointers for how to generate and develop new business models embracing the opportunities emerging from the use of CPS. This could be considered to be a *descriptive* purpose and Saunders et al. (2009) states that this is often the case, a descriptive study can be an extension of an explorative study. Nevertheless, this thesis was limited to 20 weeks and it was not viable to aim for both an explanation of the phenomenon as well as a profile describing it, which is the definition of a descriptive study (ibid.). However, from the results, pointers for what is important and what is not when generating business models will be introduced and therefore can a shallow description be provided. In chapter 7.1 *Findings and Future research* will suggestions for future, descriptive studies be presented.

3.2. Research strategy and Research design

First off, different research strategies and research designs are not superior to one another (Saunders et al. 2009). Although, depending on the research questions and the aim of the study different research strategies and research designs are more fit than others (ibid.). According to Bryman and Bell (2011) there are two common research strategies, a research is either quantitative or

qualitative. As mentioned above, this study has an explorative direction which are associated with qualitative research strategies (Bryman & Bell 2011).

The definition of qualitative research strategies depends highly on the aim of the study and can therefore vary by every person asked (Bryman & Bell 2011; Yin 2015; Saunders et al. 2009). However, Yin (2015) provides five features of a qualitative research, those which clearly explains why a qualitative research fits this thesis can be found below:

- A qualitative research is carried out under real-life conditions, meaning that the phenomenon is examined in its natural setting. As the aim of this study is to elevate the understanding for which impact CPS will have on today's business models and how to embrace its capabilities, it motivates for a qualitative strategy as this can only be achieved through a comparison between theories and real-life experiences.

- A qualitative research strategy is embraced when the objective is to understand a phenomenon from the participants' perspective, current in this thesis through the perspective of manufacturing industries and their digitalization.

- Qualitative studies are often conducted with the purpose of developing new concepts, concepts which explains social behaviours. This is current in this thesis through the concept of business models. This thesis has an object of describing the concepts of business model generation within a digitalized era.

Saunders et al. (2009) emphasizes on the importance of time horizons when conducting research. Since this thesis is limited to the 20-week time frame a longitudinal study is not possible. Therefore, the phenomenon to be studied, has to be studied at a specific point in time, which is how Saunders et al. (2009) defines a so called *cross-sectional* study. Cross-sectional studies often embrace the survey strategy (a quantitative approach) aiming to find patterns of association (Bryman & Bell 2011) but are also used in more qualitative researches e.g. case studies based on interviews done over a short period of time (Saunders et al. 2009).

Bryman and Bell (2011) as well as Yin (2015) argues for that a case study design is the appropriate research design when investigating a *single* phenomenon in-depth. For this study, a single phenomenon i.e. the phenomenon of CPS impact on business models, is investigated in-depth, over a short period of time. This

points on the use of a cross-sectional case study design based on interviews (Saunders et al. 2009; Bryman & Bell 2011; Yin 2015). Furthermore, a case study design is to be embraced when the nature of the research case is complex and in need of detailed, in-depth understanding (Bryman & Bell 2011). This complexity is found in the subject itself. Industry 4.0 and the current digitalization is relatively new topics and therefore is the demand for intensive analysis at hand. Furthermore, the objective of developing pointers for how to generate business models embracing the possibilities of CPS needs a detailed, in-depth explanation of the studied phenomenon, both favouring the case study approach.

3.3. Research process

As mentioned above, when doing an explorative study, interviews is a common method for data collection (Saunders et al. 2009). A research, as this thesis, with an explorative purpose relies on the collection of large amounts of data, rich of information. As this thesis seeks to explore a concept in depth, qualitative interviews is motivated as it will provide a necessary amount of information (Bryman & Bell 2011). Furthermore, by doing qualitative interviews the respondents perspective on the subject of matter can be embraced which also motivates for the choice of qualitative interviews as the participants' perspective is coveted when doing qualitative and descriptive studies.

3.3.1. Interviews

There are several types of interviews, were the two main types for interviews in a qualitative research are; *unstructured* and *semi-structured* interviews (Bryman & Bell 2011). As this thesis is based on a theoretical framework, specific concepts has been established before the start of the data collection. This motivates the use of semi-structured interviews as they rely on an interview guide, covering specific topics which needs to be discussed, in this case, the theoretical framework (Bryman & Bell 2011; Saunders et al. 2009). However, to benefit the most from qualitative interviews, the respondents should be encouraged to "ramble of" beyond the guide as this will provide input of what really is important for the interviewees (Bryman & Bell 2011).

Moreover, Yin (2015) emphasized on that qualitative interviews is more like a conversation and participants may be more or less direct in their answers. To understand what is being said, the researcher must be active and really listen to

the respondent and make a distinct effort to understand all that being said, both by direct and indirect input (Yin 2015).

According to Yin (2015), when doing qualitative interviews there is six factors to take into consideration.

- ***Speak in modest amounts.*** It is of importance when doing qualitative interviews to speak less than the respondent. The first and best way of making sure of this is the case is to ask *open* questions which cannot be answered by a simple yes or no. Furthermore, a tactic which was proven effective in this thesis was to stay quiet, just for a little longer time than what is comfortable, it made the respondent elaborate further, an approach also discussed by Yin (2015).

- ***Being nondirective.*** The ambition of qualitative interviews is to let the respondents vocalize their own priorities and describe their own social world with their own words. It is therefore important to ask as nondirective questions as possible. This is hard to stand by when doing interviews, especially after a few of them. After a number of interviews somewhat of a conclusion has started to form, it is of importance to not probe for wishful discussions strengthening these findings.

- ***Staying neutral.*** This is closely related to being nondirective. It is important to stay neutral in your expressions and your body language, otherwise, if the respondent notice your approval or disapproval of a subject, they may start trying to please you which will result in bias. As the goal is to not only test the theoretical framework but also to find any missing concepts, staying neutral is of great weight. In this thesis, as the interview guide was relatively structured, this was achieved by reacting positively towards the respondents' answers. By ensuring the respondent that they answered the question as desired (even though they may not have) it will give them the confidence to elaborate further and thereby it is ensured that collected data is the respondents' opinions on the topics stated in the interview guide.

- ***Maintaining rapport.*** In this thesis this was not a problem as the nature of the research questions itself are doing this naturally.

- ***Use an interview guide.*** This has been embraced when conducting this study. An interview guide is not a strict description of how the interviews

are to be done but rather memos making sure that important questions and topics are discussed. Bryman and Bell (2011) states that by using an interview guide, the dependability of the research is strengthened, dependability is further discussed in the section 3.5.1 *Trustworthiness.*

- ***Analysing when interviewing.*** When doing qualitative interviews, the analysation of data needs to start while doing the actual interview i.e. to be able to ask the right follow-up questions and probe for more details. This aspect has been one of the hardest one to embrace. It is troublesome to stick to analysing data for the right probing and not with the purpose of utilizing the data together with earlier collected data. This is problematic in two ways, one; if the respondents' talks about something not aligning with earlier found data it is easy to not pay as much attention as needed, two; the interview is not done in a neutral way if the probing is done not based on what the respondents' are saying but rather on earlier conclusions.

Moreover, most of the interviews were done over the phone. Bryman and Bell (2011) discussed issues associated with the use of telephones instead of conducting the interviews face-to-face. First off, they stated that this is not an appropriate method if a part of the sample may have no or limited access to a phone, this was not a problem for this thesis. Secondly, they state that for longer interviews face-to-face interviews are better suited than phone interviews as it is easier for respondents to finish of the interview over the phone. When conducting these interviews, this was not considered a problem as the interviews were booked far in advance and the respondents were told how long the interview was planned to be, hence, they were prepared for the interview and all respondents had set aside a sufficient amount of time for the interview. The third issue associated with phone interviews is that it is not possible to study body language. Even though body language in many studies is of importance it is not important in this thesis as it has a more technical approach and the questions asked are not on a personal level. Furthermore, as technology has reach far enough, no special recording devices or such was needed and the conclusion was due to above, that telephone interviews were the easiest choice of method. (Bryman & Bell 2011)

3.3.2. Sampling

A typical issue with qualitative researches is the lack of transparency, especially in the aspect of sampling (Bryman & Bell 2011). Bryman and Bell (2011) stated that the problems foundation is that many researchers argues for that the in-depth analysis of a very specific phenomenon, which is the case when conducting qualitative research, makes the representativeness of the sample less important. The aspect of representativeness will be further discussed in section 3.5.1 *Trustworthiness*.

According to Yin (2015), data is collected from a unit, in this thesis these units corresponds to the respondents participating in the study. The challenges arising in the sampling process is twofold. First off, the respondents participating is to be chosen and it is of great importance to understand why these specific respondents were chosen. Secondly, a decision has to be made regarding how many interviews there are to be done, and why, which is especially hard when only relying on a single data collection unit. According to Yin (2015) the samples in a qualitative research are often done in a deliberative manner, this is called *purposive sampling*. (Yin 2015)

Throughout this study, purposive sampling has been performed as it aligns with a studies goal for an in-depth investigation of a case (Saunders et al. 2009). It was established that the respondents had a profound knowledge of the subject and that they also were employed by a manufacturing firm going through some sort of digital transformation. However, a minority of the sample was not employed at a manufacturing firm but did have a deeper, more extensive knowledge on the subject and was therefore chosen for participation.

Moreover, as this thesis is limited to a 20-week time frame, the number of respondents has to be kept to a minimum without excessive bias in the result. Yin (2015) argued for that when conducting qualitative research, the sampling size do not have the same impact as in a quantitative research and the sample itself is more important than the sampling size. For this thesis a purposive sample was used with the demand for a fundamental knowledge on the subject. Moreover, the respondents were deliberately chosen, to the possible extent, by their employment and role in the organization, to get a broader understanding for how different people and organizations approaches a digital transformation and what the benefits are to them. As the time is limited and a purposive sample has been used, a sample size of seven was chosen which was considered enough based on Yin's (2015) discussion on sample sizes in qualitative studies.

3.4. Analysis method

When analysing data, the relationship between data and theory has to be established. Bryman and Bell (2011) stated that this is either done in an inductive or deductive manner. However, Le Duc (2007) argued for that qualitative studies also can be done in an abductive manner, which is a mix of the two former. This thesis has an overall *inductive* approach where collected data are to be used for establishing new concepts (Yin 2013), i.e. What is Industry 4.0, and how CPS affect business models. However, also aligning with the definition provided by Yin (2013) of a *deductive* approach, this thesis starts with the establishment of known concepts, i.e. the theoretical framework, to define which data that is needed. The conclusion is that this thesis is carried out with an abductive approach (Le Duc 2007). In figure 9 is the inductive and deductive approach respectively described in the context of this thesis.

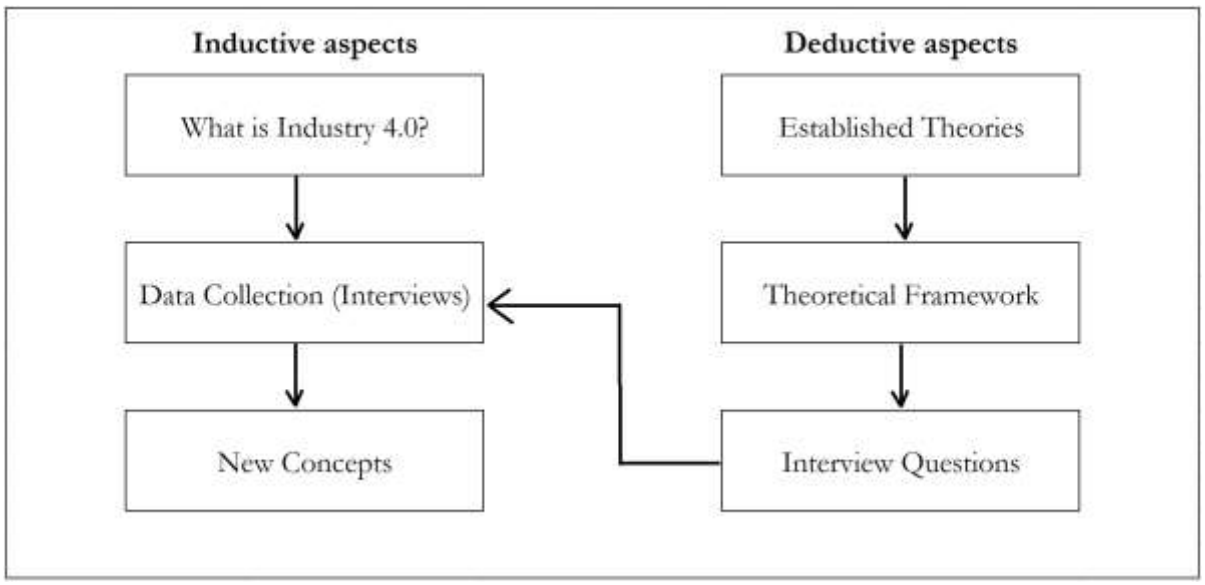

Figure 9: The inductive and deductive aspects of this thesis.

Saunders et al. (2009) stated that the theoretical framework is much helpful for organizing and direct the analysis as it can be used as an *analytic framework* for comparison between data and theories. However, the data needs to go through further steps before it can be compared to the analytic framework (Yin 2013; Saunders et al. 2009). All read theories around qualitative data analysis (Bryman & Bell 2011; Saunders et al. 2009; Yin 2015; Collis & Hussey 2013) presented similar ways of analysing qualitative data, i.e. to disassemble/categorize data, interpret/compare data, and finalize/conclude data. The analyse process of this thesis will be based on this generalized process, accepted by above mentioned researchers.

First off, the interviews need to be transcribed and summarized to the key points (Saunders et al. 2009), the data will then be divided into categories (Bryman & Bell 2011; Yin 2015), the first disassemble/categorization of the data will be based on the presentation of data, which will be done from two perspectives related to two personas *The Reacher* and *The Settler*. The Reacher and the Settler are two fictive persons, which arose from the data collection phase. A clear division amongst the respondents was seen; one group focused on the internal benefits of utilizing digital solutions and did not experimented with new concepts; another group were constantly trying to evolve, challenging themselves and developing new concepts and methods for utilizing digital solutions and creating value. This division will act as the first categorization of data. Furthermore, after the initial division, the data will be categorized based on the theoretical framework (ibid.). See figure (10).

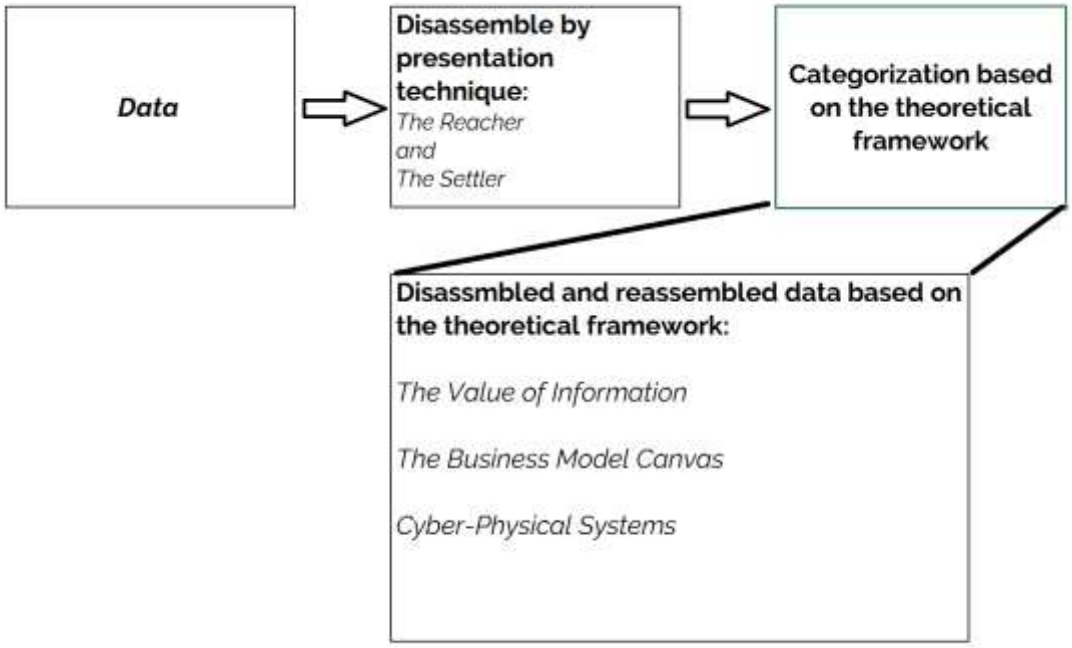

Figure 10: The categorization of data, based on the theoretical framework. The data is reassembled in blocks of information; these blocks are based on the different themes in the theoretical framework.

The next phase is interpretation (Yin 2015). When the data has been interpreted, the findings are to be compared to the theoretical framework and from the likelihoods and differences between theories and findings, a conclusion can be drawn (Yin 2015; Bryman & Bell 2011) see figure (11).

Figure 11: The data analyse process from data to conclusion.

3.5. Methodology discussion

This section is dedicated to discuss the validity and reliability of this thesis. However, Guba and Lincoln (1985; 1994 referenced in Bryman & Bell (2011)) introduces another criterion for evaluating a qualitative research as the criteria validity and reliability aligns more with quantitative research. This new way of evaluating qualitative researches is called *Trustworthiness* (ibid.) and is further elaborated on in the section below.

3.5.1. Trustworthiness

When evaluating qualitative studies, the concept of trustworthiness is to embrace (Bryman & Bell 2011). Trustworthiness consists of four different factors to evaluate, *Credibility*, *Transferability*, *Dependability*, and *Confirmability* (ibid.).

Credibility

The criteria credibility refers to the match between the findings and the theories developed from them. Qualitative studies are associated with in-depth investigation of social realities and this narrow focus on specific questions tend to ensure that the credibility is high. For this thesis, actions have been taken to ensure that the credibility is strengthened. This was done through so called respondent validation, a summary of the interview was sent back to the respondent so that they could confirm that their opinions and knowledges had been understood correctly. (Bryman & Bell 2011)

Transferability

Qualitative research is defined by its depth and intensive analysis of a smaller group with similar characteristics, or a single phenomenon and the *transferability* can therefore be questioned. Transferability is the criteria which regards the findings possibility to be generalized across social settings. In this thesis the transferability is ensured through the theoretical framework, which summarize

and defines the theories associated with the study. Further on, the empirical data is presented in a pedagogical and descriptive way and the conclusions is based on the comparison between empiricism and theories to ensure that the reader understands the logic behind the study. (Bryman & Bell 2011)

Dependability

Dependability refers to studies ability to be replicated. The best way to strengthen the dependability is to adopt an auditing approach. However, the auditing approach has not been widely acknowledged as it is time consuming and demands a lot from the auditors. Hence, it has not been adopted for this thesis. However, the interview guide and the empirical data is presented and will give the reader some understanding for how the study was conducted. (Bryman & Bell 2011)

Confirmability

Confirmability is the last criteria underlying trustworthiness and equals *objectivity*. It is established that total objectivity cannot be achieved in business research as the interpretation of data and the understanding for the social world studied will depend on the researchers own knowledge, experience, and social reality. In this thesis, the confirmability is strengthened by the respondents' validation as they can certify that the findings reflect their understanding of the phenomenon studied. (Bryman & Bell 2011)

4. Empirical study

This section was developed with the aim of presenting the gathered data in the most representative and educational way possible. Furthermore, the interview guide used for conducting the interviews can be found in the appendices, as well as a list of interviewees.

4.1. Interviews

As mentioned in the analysis section of the methodology, this section will present the data from two perspectives, based on two personas, The Reacher and The Settler. The presentation of data is based on; *The value of information*, *Business Models*, and *CPS*. Furthermore, the discussion will start with some general questions to provide the reader with an understanding for how the interviewees saw the subject of Industry 4.0 and the digital transformation. Furthermore, as the internal focus also could be considered more conservative, will the Settler's point of view be presented first followed by the more innovative, new-thinking Reacher.

What is a digital transformation?

The Settler emphasized on the fact that digital solutions has been used for years. Earlier were digital solutions utilized as supplementary agents to established processes. The digital transformation that is ongoing will instead utilize digital solutions and *change* how we work. Moreover, The Settler stated that different management systems and data collection has also been around for decades, it is the communication between these systems that is coupled to the digitalization of today. Through an increasing amount of data collected, as well as a faster transmission, a fully digitalized organization can become reality. The ambition is to reach a zero-scrap, super-efficient, and highly automated production. Enterprise Resource Planning (ERP) systems, Manufacturing Execution Systems (MES), Customer Relationship Management (CRM) systems, as well as Product Life-cycle Management (PLM) systems, has been around for quite some time, it is the communication between these systems as well as the production processes which this digital transformation is all about. For example, when all systems are communicating with each other, an order would be placed, directly by the customer online, the order would go through the ERP-system down to the MES-level which together with a production planning system would state which production line that is available and when. If the production processes also are automated, products could go from order to delivery without any human involvement. This is made possible through

statistics and complex algorithms. When every system, and machine, is connected to each other, collecting and communicating data in real-time, mathematics can be used to both optimize and automate the decision-making process. This would mean that data-analysis would assure that the right decision was taken as well as that quality is reached within every process. Thereby has the human involvement been minimized, which could be considered the overall ambition of a digitalization.

Furthermore, the Settler stated that the digital transformation is a result of continuous improvements. Every organization works with the ambition to always improve, and nowadays that can be done through digital solutions, hence has the digitalization started.

Another aspect which the Settler discussed was the IoT, the Settler stated that when discussing Industry 4.0, many are discussing IoT, however, IoT is not necessary. The ambition is to take everything online, to connect everything, but the ambition is to make everything connected, internally, hence should it is more about the Ethernet of Things.

The Reacher acknowledged the importance of internal aspects, those associated with the Settler, but argued for that the real digital transformation is more externally focused. The Reacher emphasized on that it is the continuous improvements that brought digital solutions internally and the transformation that is at hand regards aspects which not comes from inter-organizational optimizing, such as how to conduct business and how to use digital solutions to create and capture value in new ways. The Reacher emphasized that the digitalization will change everything, not only production, but even whole business models. The ability to collect and analyse data on a product throughout its whole life-cycle will provide necessary capabilities for optimization, development and the creation and capture of new values. By collecting data on products i.e. usage patterns, surrounding milieu, maintenance needs, and end-of-life handling the offered value can be maximized. Furthermore, every customer has very specific needs and this massive amount of new information will help companies understand their customer and thus can a maximized value be provided. Furthermore, the data will also act as basis for new innovative add-on services which complements the product. As the add-on services receives more and more focus, this digital transformation will boost the servitization. Further on, as information will help organization understand the whole value-creation process from suppliers' supplier to customers' customer organizational boundaries will blur as collaboration will maximize value.

Moreover, even if the true value of Industry 4.0 is to be found in external aspects such as the business model, internal aspects are still important. As more data becomes available together with an optimized, open, flow of information new ways for approaching problems are possible. As the digital transformation at hand mostly is about more and faster collection of data, this data will provide organization with new point of views, new approaches to traditional problems which will help the industry as whole to overcome these traditional problems and elevate the manufacturing industry as whole, reaching higher levels of efficiency and quality.

How would you define a smart product?

The Settler focused on the internal value creation rather than value creation for customers. According to the Settler, a smart product is simple i.e. simple to use and to understand. Furthermore, it should seem custom-made by customer demands but should be standardized as it eases production. It should also be hard for competitors to copy. However, it is still emphasized that the ambition is to sale a value rather than a product, nevertheless, maximized value should be created for minimized production costs.

The Reacher stated that a smart product should create value beyond the initial function of the product. To be able to deliver that elevated value, a wider approach to the value-creation process is needed. Through the utilization of digital solutions, products can communicate in real-time, providing necessary data showing how products are used throughout all steps in the value-chain. As knowledge of the usage is obtained, optimization of products can be made as well as additional services can be offered to elevate the total value perceived.

Furthermore, the Reacher stated that in a digitalized era is the approach to product development about to change. As it is established that through data can perceived value be elevated i.e. through additional services or product optimization and development. This means that more focus will be put on data collection already in the design process. The product must be able to, beside its original function, to collect and present data. The presentation of data will receive much more focus as the data will not be useful if it is not understandable. This means that a more cognitive focused design process will take place, focusing on how to make data understandable.

What is the value of this information becoming available?

The Settler saw the real benefits of a digital transformation in the ability to control processes by statistics. By the collection of large amounts of data, gathered in real-time, processes and quality assurance can be controlled automatically through algorithms. The value of information is thereby all about the decision-making process. The decision-making efficiency can be significant better as data collection is faster, and larger. Traditionally, key performance indicators were coupled almost exclusively to number of details produced. With new types of data made available as well as larger amounts of data collected and analysed faster new key performance indicators could be developed. With new indicators will the decision-making process be made more efficient as well as it will assure that wishful results are obtained.

Furthermore, the ambition is to utilize CPS to automate the production processes as well as the decision-making process as it will minimize the human involvement. Humans i.e. operators, needs to interpret data and instructions, as well as each other and then also make us of the information which leads to an increased risk for errors. The true value of information is the capability to minimize human involvement as it will minimize scraps.

However, the Settler does also found value in information as condition monitoring. Condition monitoring has been around for many years but the digitalization has taken it to a whole new level. Nowadays, total breakdowns can be almost completely eliminated.

Another aspect of data utilization is the ability to improve Lean practices by utilizing digital solutions, gathering and presenting data in a clear and interactive way.

The Reacher argued for that the value of information is strictly coupled with the capability of monitoring. As products can be monitored, preventive maintenance can be performed as well as optimizations and improvements based on usage patterns. In the future will the value of information be found in the possibility of complex analysis. With new complex analysis can big data be turned into smart data and fed back, making the systems self-aware and self-configuring. The Reacher emphasized again on more external usage, how the value of information can be found in the understanding of customers. As the understanding is elevated, additional services can be developed increasing the

value perceived by the customer. As this transformation is going on, the manufacturing industry also begins its servitization.

How should Cyber-Physical Systems be utilized?

The Settler stated that CPS enables a new level of data leverage. Earlier was the *right* data collected at the *right* time. This narrow approach to data collection meant that systems were specialized for their own task. CPS has now brought the capability of a more open-minded data collection which brings opportunities for better data-leverage. In general, the ambition of CPS-utilization is automation. Higher level of automation throughout the production as well as an automated flow of information is the goal of CPS-utilization.

Moreover, as Lean-principles are based on data and information, according to the Settler, one of the biggest benefit of CPS, besides automation, is the possibility to strengthen Lean-practices throughout the organization.

The Reacher however, wanted to divide the subject between CPS utilization in production, and in products. CPS is far more utilized in products, collecting data, in real-time, all the time. This data is made available through CPS. In production however, CPS has not reached the same level of utilization. The implementation of CPS has started, but with the ambition of automation and it has been done as optimization-efforts for bottlenecks throughout the production process. This has led to sub-system optimization for the machines individually, the next step is to connect all these sub-systems into one system in which every machine and all supply chain systems (i.e. ERP, CRM, MES and more) are connected, communicating with each other. When this connection is established, data can be collected, communicated, and analysed through all processes and machines, enabling the machines to make decisions themselves. Further on, through CPS, it is possible to create a virtual world where all machines (and products) have a virtual twin. The virtual world is something that could be considered the final stage of CPS utilization and the ambition is to leverage the virtual world through simulations.

However, the Reacher also discussed the obstacles for CPS utilization. It is stated as neither cost nor complicated process, it is traditions. Products are design with the fundamental adoption that humans need to be included in the process i.e. operators. This means that products are designed in a way which makes it unfeasible to fully automate the production of it. To utilize CPS fully in production, a new approach to the design process is needed.

How has your Business model changed by the utilization of CPS?

The Settler argued for that CPS has not changed the business model in a direct way. New technologies have made it possible to offer new products and services, but these have not developed from CPS-opportunities rather than customer demands. Nonetheless, the digital era has made it possible to come closer to the customer and through a closer relationship, a better understanding of the customers has been achieved. As a more in-depth understanding is reached, a more complete solution can be offered. Through the use of CPS, both spoken and unspoken needs can be understood better and both products and additional services can be offered to provide maximum value for the customer. However, the Settler was persistent to ensure that they are still selling products and do not want to discuss the servitization. The whole, service-dominant or goods-dominant logic is only means for a company to make it possible to state that you are world leading on one thing. If you are selling products, you are selling products, and that is the end of it.

Further on, the Settler emphasized that business models are often well-established, especially in larger firms, and to break-up an established business model is coupled to gigantic risks.

The Reacher on the other hand agreed on that digital solutions have opened a whole new world of add-on services and states that the servitization of the manufacturing industry has begun. The Reacher emphasized on that this transformation towards service providers will come naturally as add-on services will be given more and more focus. New technologies and digital solutions will open up for new innovative ways for creating value and companies which dare to approach this digital transformation with open minds will found its true value in whole new ways of conducting business. Also, as products are becoming more alike, the competitive advantages are therefore found in the additional value beyond the products base value. A company needs to embrace a business model based on selling "value-packages" instead of products and/or services. The Reacher emphasized again on that the digital transformation drives the servitization and elaborates; as services is taken more place, the question regarding responsibility arises. If a product is good enough a company may keep responsibility for it and only charge the customer for usage. In this case, maintenance, which earlier would be an extra income, becomes a costs. Moreover, the digitalization has brought a relationship focus, e.g. collaborative optimization-relationships, where supplier and customers help each other

optimize their business and divides the winnings amongst them creating a win-win situation.

However, the question of servitization is elaborated on; it is doubtful if everyone will be fully servitized. Nonetheless, even if the business model fully centres around the fact that the firm is selling tangible products, a more service-dominated mind-set is needed. As customer demands are complex, a company will never deliver the right value only be delivering a product by itself. To provide the right value, at a beneficial level, the least a company needs to do is to help their customer optimize the usage of the product.

Moreover, the digitalization will also change how business are conducted in a monetary aspect. This is highly associated with the question of responsibility discussed above, but if a product is good enough to deliver value to the customer over a long period of time, it should bring a long, steady stream of revenues as well. This monetary aspect is also coupled to the collaborative optimization discussed above, as revenue streams in that case would not be based on sales of products rather than the winnings done by the customer when using the products and services provided. This is also fruitful in a dynamic and volatile economy. Suppliers would get paid more steadily over time and customers would not need to pay when they are not using the products e.g. this means that investments done in strong economic times do not bankrupt companies when the economic growth stops.

Can you see any specific change to your value proposition?

The Settler very firmly stated that the value proposition is based on customer demands and nothing else. No changes have been made to the value proposition based of CPS.

The Reacher stated that the value proposition is nowadays consisting of both products and services, a value-package, which creates value for the customer on several levels. The digital transformation has made the market more dynamic and complex and the demand for integrated solutions solving problems through a wider perspective is current. This means that the value proposition needs to be even more based on the individual customer's demand. The digital transformation has made it possible to create and capture value in new innovative ways, however, the value proposition is always based on customer demands, not technologies. The Reacher stated however, that a new popular way of distributing the value proposition has arisen with the digital era; Cloud

Computing, where products are sold merely as base and the real value is found in the cloud.

The Reacher declared that the digitalization has brought change to the value proposition, although, it is based on; one; customer demands are becoming more complex and it has therefore brought the development of digital solutions, two; digital solutions has opened up for new ways of creating and capturing value e.g. thought add-on services. However, the value proposition is still based on customer demands which may or may not demand technical solutions. The digital transformation has merely made it possible to utilize digital solutions in the value proposition, it has not changed the value proposition on its own.

Can you see any specific change to your partnerships?

The Settler stated that partnerships are formed to help each other optimize and develop each other's production. As the digital transformation has made production processes considerable more complex it drives partnership. It is not viable to have all the needed competence inside the own firm. Instead, through collaboration can the production be improved and optimized through knowledge-sharing.

The Settler emphasized on that the digitalization has not promoted further specialization and that specialization should be approached with care. Nowadays, as the value-creation has become that complex, many organizations are mistakenly sorting out important core-competences as support processes as they lack understanding for the complex value demanded by the customers. Thus, if an organization is to specialized they might be missing some competences which would ease their own value-creation.

The Reacher emphasized on that the digital transformation drives the servitization, and the servitization drives collaboration. For a company to be able to provide their customer with a wider value-package consisting of both products and services maximizing the value for the customer, collaborative actions have to be made to ensure value-maximizing propositions. However, The Reacher stated that the fundamental aspect of partnerships is that every company should focus on their own core competence. To be able to compete on a dynamic, quickly changing market, partnerships needs to be established in which core competences are shared to provide the common customer with the highest possible value. The Reacher, in opposite to the Settler, stated that it all comes down to specialization. To stay competitive, a company needs to focus

only on their core competence, and challenges themselves as it will keep them from staggering and losing their competitive advantage. Moreover, as the deprecation increases a focus on core competences will help the company to keep up with the ever changing market. By focusing only on core competences and establish partnership for support processes, the company can stay competitive.

Furthermore, the digital transformation at hand has put a lot of focus on transparency, openness, and data-sharing. It is important when discussing this subject to separate products and production. Information regarding production should be openly shared as it will help the industry as whole as it will help everyone to optimize and evolve. Spreading information around products on the other hand should be approach cautiously as that is a companies' competitive advantage. However, both the Reacher and the Settler agreed on that to this day, security has not reached wishful level and many organization embraces a precautionary approach to openness and transparency.

Furthermore, on the subject of partnerships, the Reacher stated that it is somewhat of a trend to focus on new ways to utilize established innovations rather than creating new ones. This means that a lot of industries are looking towards each other hoping that innovative ways for creating value in one industry could be reused in an adopted way inside their own industry, which also drives collaborations.

5. Analysis

The analyse procedure was explained in the methodology section and will be a comparison between collected data and the theoretical framework, again, as with the presentation of the results, this will be based on the three themes introduced in the theoretical framework. However, to provide a clearer connection to the aim of this thesis, the theme Business Models will be analysed with the research questions at base.

5.1. The value of information in a digitalized era

The value of information in a digitalized era, especially from an Industry 4.0 perspective, mainly relates to new innovative ways for creating value. However, Cao et al. (2015) stated that the value of information is captured in the decision-making process. Cao et al. (2015) defined decision-making efficiency as a company's proficiency at making rea-time decisions, respond to change, and their understanding of their customers. This aligns with the focus of the Settler. The Settler had an internal focus and approached the digitalization with the ambition to improve and optimize inter-organizational aspects. Traditionally, an effective and data-based decision-making process was considered to be the foundation of an ever optimizing and evolving business (Barton & Court 2012; Cao et al. 2015; McAfee & Brynjolfsson 2012). The Settler saw the value of information in the opportunity to make the decision-making process more efficient and optimized. Moreover, the value of information is not only found in the optimization of decision-making, but by the use of digital solutions and CPS new data can also be gathered. With new types of data available is it possible to utilize new key performance indicators which better fits the ambition of the organization. Therefore, the value of information is, related to decisions, twofold, one by the optimization through more and faster collection of data, and one from the development and improvement of key performance indicators more fit to the business goals. Furthermore, those with an internal focus, when discussing beyond an efficient decision-making process, saw the value of information in the possibility to also automate the decision-making process. As all types of data is collected in real-time, all the time, statistics and algorithms can be utilized to automate the decision-making process. This can be seen as the last step of the transition towards a fully automated production without any human involvement. The Settler argued for that the true value of information and the ambition of Industry 4.0 is to achieve a fully automated, zero-scrap production, which is possible by the minimization of humans. This is closely related to Mittermair's term "automation of automation", where machines have

been fully automated and the automation has moved on to the decision-making process, made possible through the use of CPS and advanced, statistical algorithms (Mittermair 2015).

It is also emphasized by earlier research that to stay competitive and to keep evolving and optimizing, data-utilization is the key (Parmar et al. 2014; Cao et al. 2015; McAfee & Brynjolfsson 2012; Barton & Court 2012). Kolberg and Zühlke (2015) further elaborated on the utilization of data to stay competitive and keep evolving. They discussed what they called "Lean automation" where digital solutions was utilized to elevate an organizations Lean-practices. It is shown through the results that the Settler saw continuous improvements and Lean principles to benefit from data as well.

Moreover, in the theoretical framework it was stated that there are four types of data utilizations i.e. monitoring, controlling, optimizing, and automating (Heppelmann & Porter 2014). The Reacher approached the value of information by its external benefits which aligns with the possibilities discussed by Heppelmann and Porter (2014). However, the Reacher mainly discussed the capability of monitoring. The most fundamental usage of information is condition monitoring where preventative maintenance can be offered based on monitoring the condition of machines and products. Parmar et al. (2014) also defined the collection and analysis of data as the first utilization of data. Heppelmann and Porter (2014) stated that remote controlling is the second level of data utilization but that is never discussed amongst either the Settler or the Reacher. However, the Reacher elaborated on the capabilities of monitoring and stated that if data collection and monitoring is combined with advanced analytics, machines could be made self-aware and self-configuring. This ambition aligns with Heppelmann and Porters (2014) third and fourth level of data leverage. If machines and products are monitored, and possible to remote control (even with algorithms as discussed by the Reacher) they can be optimized and automated to new levels.

Furthermore, both Herterich et al. (2015) and Heppelamann and Porter (2014) emphasized on that data will provide new innovative ways of creating value. The Reacher was not admitting to actively see this connection, although the Reacher stated that the digital era has brought them closer to the customer which has enabled the development of their value proposition now containing both products and services i.e. new ways of creating value. Parmar et al. (2014) did also discuss data utilization in form of combining data across industries, trading data, and codifying a distinctive service capability. These types of data-usage

have not been embraced, although, transparency, openness, and new types of collaborations is understood by both the Settler and the Reacher to be important and upcoming, which points on Parmar et al. (2014) areas of utilization i.e. if a secure way for handling data can be developed which is stated to be the lacking factor to this day.

5.2. CPS and their utilization

Lee (2006) defined CPS as embedded systems which enables the integration of physical data and computational data. CPS are also defined to have the network capabilities enabling communication of this data (ibid.). The Reacher and the Settler had similar ambitions of CPS-utilization. CPS should be utilized for data collection and data presentation as well as to automate production further. The Settle wanted to automate the production even more as well as the flow of information throughout the organization. The Reacher had besides that also a long-term ambition of a virtual reality where everything in the factory, i.e. both machines and products has a virtual twin.

Lee et al. (2015) developed a five stage implementation architecture of CPS in an Industry 4.0 manufacturing firm. Connection is the first level; CPS should be used for data collection as machines and products becomes connected. The second level was Conversion; the transformation from big data to smart data. The first and second level is highly current in manufacturing firms of today according to both the Settler and the Reacher. Enormous amounts of data are collected in real-time from all processes and analysis is given more and more focus for each day. The third level is called Cyber and represents a hub where all information is gathered. It is the third level which is lacking in real life. As stated; the implementation of CPS is essential from continuous improvement of bottlenecks. Thus has the implementation of CPS this far been an optimization of sub-systems, or production-islands. The Settler even defined the current digital transformation to be about the communication between all systems, to combine all sub-systems into one system i.e. the Settler stated that the ongoing digital transformation in many ways is about the third level of CPS implementation, the hub, and the connectivity amongst all systems. However, stage four, Cognition, and stage five, Configuration, i.e. data presentation and the feedback loop respectively has already been reached in many manufacturing firms as the original ambition of CPS utilization mostly was coupled to automation, and advanced automation with self-aware machines and more, which in some manufacturing industries has been utilized for years.

This early and advanced approach to automation is a problem as many sub-system has been given their own solutions and thereby hampered the capability for utilizing the cyber stage. (Lee et al. 2015)

5.3. The Business Model

As the aim of this thesis was to understand the impact CPS will have on business models, this section of the analysis will also be divided by the research questions, which all four are coupled to business models, see below;

RQ_1: *What impact will Cyber-Physical Systems have on business models?*

RQ_2: *How should business models be generated and/or developed to include the benefits of Cyber-Physical Systems?*

RQ_3: *How will Cyber-physical systems change the value proposition?*

RQ_4: *How will Cyber-physical systems change key partnerships?*

5.3.1. CPS and the Value Proposition – RQ_3

Heppelmann and Porter (2014) stated that Industry 4.0 and foremost smart products will bring new ways for creating and capturing value. They discussed that the digital transformation will evolve products to contain more than just mechanical and electrical parts but also embedded systems and communication capabilities (ibid.). The bottom line is that the value proposition is about to change as the digitalization continues. However, it is clearly stated, by both the Settler and the Reacher, that the value proposition is based upon the customer segment and the customer demands. The Reacher stretched further than the Settler in the discussion around value proposition and mentioned that new products and services has been made possible through digital solutions. However, these digital solutions merely made it possible to provide new value propositions, they are not based directly of new technologies. The value proposition is strictly based on customer demands, which nowadays, demands digital solutions. This approach to the value creation aligns with the BMC which is based on the customer segment (Osterwalder & Pigneur 2013). The customer segment is the first block to be established in the BMC followed by the value proposition (ibid.). The Lean Canvas do also start with the targeted customer group, thus, as both theories (Osterwalder & Pigneur 2013; Maurya 2010) and the results indicates that the value proposition is second to customer segment it is considered an established concept for determining the value proposition and

customer segment. This concept does also imply that it is valid to assume that CPS will not change the value proposition in a direct manner.

5.3.2. CPS and Key Partnerships – RQ_4

Lusch and Nambisan (2015) argued for that the servitization promotes an approach to the market as a network of actors, where actors are cooperating to innovate and create value. Vargo and Lusch (2008) did also discuss how collaboration is needed in a service-dominant logic where value are to be created collaboratively throughout a value-chain. Furthermore, Fischer et al. (2014) stated that the servitization of the manufacturing industry has begun and are based on that merely products themselves are not competitive enough. The Settler, with its internal focus emphasized that partnerships are established to help develop each other's production as nowadays, production processes are that complex that collaboration is needed for optimization and improvements. The Reacher on the other hand stated that the value proposition nowadays is more of a value-package consisting of both products and services and to be able to provide a package of maximum value, the value-chain concept needs to be embraced. In other words, to keep the competitive advantage, more than just a product needs to be offered, a value-package (Fischer et al. 2014), and to be able to deliver a value-maximizing package, an understanding for the whole value-chain is needed i.e. the network/collaboration approach (Lusch & Nambisan 2015; Vargo & Lusch 2008).

Furthermore, the Reacher emphasized that to stay competitive and keep up with the dynamic market of today, specialization is at hand. A company should seek out their core competence and focus solely on that competence. Collaborative partnerships are then expected to provide the company with sufficient support competences. This is the approach to business models adopted by Phole et al. (2005). They introduced the concept of internal and external specialization where external specialization, in its final ambition, is called *Industry networked*, where a firm is specialized on its core competences and acts within an ecosystem in which all contributes by their specialization to create value together.

Also, Plattform Industrie (2014) defined Industry 4.0 as concept for value-creation throughout the value-chain. Both the transition towards service providers and the digital transformation speaks for a more collaborative industry in the future. In the bottom line, both theories and results indicates that the digitalization will drive collaboration, therefore is it reasonable to assume that more focus be put on key partnerships, which today is block number eight

out of nine in the BMC (Osterwalder & Pigneur 2013), in the future, key partnerships may need to be given more focus earlier on in the business model generation.

5.3.3. CPS and their impact on Business Models – RQ_1

Fischer et al. (2014) stated that the manufacturing industry is already under a transition towards becoming service providers. The Reacher agreed and emphasized over and again that the digitalization probably will drive the servitization. The Reacher based this on that digital solutions helps them understand their customers as well as making it possible to provide add-on services and that more focus will be on delivering a value-package. This value-package consists of both products and services with an increasing focus on mentioned add-on services. This increased focus on services shows that a servitization is ongoing. It is also said that since the products are becoming more alike, the competitive advantage can be found in the add-on services. Fischer et al. (2014) stated exactly the same, merely products are no longer sufficient as competitive advantage. Vargo and Lusch's (2008) nine fundamental aspects of the service-dominant logic also stated that goods only are tools for service distribution, which aligns with the fact that add-on services are given more of the focus. To elaborate, CPS has provided manufacturing firms with the sufficient needs to boost the servitization i.e. it is likely that the business model as whole will be more service-dominant. A business model should consists of nine building blocks, two (key partnerships and value proposition) is discussed above, the third block is distribution channels and the fourth is customer relationships. Even though no specific change has been mentioned, both the Settler and the Reacher emphasized that the digital transformation at hand has brought them closer to the customer, in other words, changes to both distribution channels and customer relationships is about to transpire.

Moreover, as the Reacher discussed, will the block revenue streams change as an indirect effect of CPS utilization. With the capability of monitoring and remote controlling new innovative business-concept has risen. When it is possible to remotely monitor and control products a company can keep the responsibility for the value creation from their product and charge the customer in new ways. As mentioned, pay-per-use, only uptime-charge and other non-transactional based revenues are assumed to develop from a digitalized industry.

5.3.4. Business Model development and CPS – RQ_2

This study is of an explorative nature and the result will only provide pointers for this research question. How business model generation should be done in the future to benefit from digital solutions and CPS is therefore not confirmed by this study, although, this study does provide an understanding for what is thought to be more important in a digitalized industry.

Vargo and Lusch (2008) argued for that all economics are service-economics and that the exchange of value on a market always are exchanges of services. Fischer et al. (2014) did also argued for that the manufacturing industry is moving towards becoming service providers instead of product manufacturers. From the result it is validated to assume, that even though not everyone wants to label themselves as service providers, services are given more attention for each day. Business models will most likely be more based on a value-package proposition, consisting of both services and products as the results showed that it is established that merely products are not competitive enough on their own, as Fischer et al. (2014) also stated. Furthermore, aligning with Vargo and Lusch (2008) statement, goods are only distribution mechanisms for services, the result showed that add-on services are presumably to conceive more focus in the future and the product itself is considered more of a platform.

However, both the BMC and the Lean canvas starts with the establishment of the customer segment (Osterwalder & Pigneur 2013; Maurya 2010). The respondents were all very eager to ensure that all value propositions are based solely on customer demands. The value proposition is then defined secondly (ibid.). It was also discussed throughout the study that all respondents considered themselves to be closer to their customers, which resulted in a better understanding for both spoken and unspoken needs. This was established to be a direct result of the digitalization and are in terms of the BMC a change to block three and four, distribution channels and customer relationships. However, even though partnerships and collaborations have had an increased focus in the theories (Heppelmann & Porter 2014; Brettel et al. 2014; Herterich et al. 2015; Koch et al. 2015) they are more coupled to the block key partnership in the BMC and which changes to expect to distribution channels and customer relationships is therefore not established. Furthermore, as mentioned, key partnerships are expected to receive more focus in a digitalized industry. It is established in the result that a dynamic, ever changing market puts a lot of pressure on companies and to be able to keep evolving and stay competitive, further specialization may be the solution. Core competences should be defined

and networking should then provide necessary support competences. Core competences could be a parallel to the BMC's key resources and key activities. Key resources, key activities, and key partnerships are the blocks six, seven, and eight out of nine (Osterwalder & Pigneur 2013). From this thesis it is assumed that these will be of more focus in a digitalized industry, which argues for that they should be established earlier, as a more central part of a business model.

The Component Business Model, CBM, was developed with specialization in mind (Phole et al. 2005). The five dimensions of a business component (figure 6) is produced to assure that a component is necessary for the business (ibid.). Therefore, it could be useful to utilize the CBM's five dimension-model to establish which competences that are to be considered core competences. Furthermore, by utilizing the five dimension-model on partnerships, can collaborations be established, or felled, based on their impact on core competences.

6. Conclusion

This section will feature the outcome of the study and will answer the stated research questions with a short explanation of the answer.

6.1. Cyber-Physical Systems and the Value Proposition

Cyber-Physical Systems are expected to change the value proposition, but only in an indirect way. Even though research points on that the utilization of Cyber-Physical Systems will bring new innovative ways for creating and capturing value, the result showed that no of the studied organizations had developed new value proposition based on new technologies made possible through Cyber-Physical Systems. The value proposition is always, and only, based on the customer segment chosen.

However, the results did show that Cyber-Physical Systems has brought the capabilities to offer new value propositions. New products and services has been developed thanks to Cyber-Physical Systems, but only after a customer demands it. The digital transformation ongoing has merely brought the opportunities to provide digital solutions and add-on services based on technologies.

To summarize, Cyber-Physical Systems are assumed not to change the Value proposition. Although, it has brought the opportunity to further fulfil customer demands through digital solutions and new services.

6.2. Cyber-Physical Systems and Key Partnerships

Key partnerships will likely conceive more focus and be more off a central part in a digitalized business model. As a business model cannot be based seldom on products or service for a business to stay competitive, a combination of both needs to be offered, a value-package. This value-package is complex and built of several products and/or services. Thus, a collaborative value-chain approach is considered desirable, as only through collaboration will the whole package function together and provide the customer with maximum value.

Moreover, as the market, in a digitalized era, is both more complex and volatile, businesses may need to specialize themselves even more and focus merely on their core competence. By building a network where all actors cooperate by combining core competences can business stay competitive, dynamic and ever evolving and also deliver maximum value to their customers.

To summarize, in a digitalized manufacturing industry it is assumed that more businesses will be based on collaboration. The mere survival of some businesses may even be based on their ability to cooperate with other actors on the market and thus will key partnership grow as building block. Key partnership will change, mostly to its extent as more business forms partnerships both for survival and value-creation.

6.3. Cyber-Physical Systems and their impact on Business Models

In general terms, Cyber-Physical Systems are what enabled the digitalization of the manufacturing industry. It is established throughout the thesis that the digitalization will further boost the servitization. Therefore, Cyber-Physical Systems will shift business models to focus more on services than products.

Further on, a business model should consist of nine building blocks and these are; *Customer segment, Value proposition, Distribution channels, Customer relationships, Revenue streams, Key resources, Key activities, Key partnerships,* and *Cost structure* (based off the BMC, see figure 4). It was established through this thesis that the Value proposition will be indirectly affected by Cyber-Physical Systems utilization as Cyber-Physical Systems brings the opportunity to provide the customers with new smart products and additional services. Moreover, throughout the interviews it was emphasized by the respondents that the digital transformation has brought them closer to their customers i.e. changes to Distribution channels and Customer relationships. Revenue streams were discussed with those respondents with an external focus (the Reacher) and as products are becoming smarter, new ways for conducting business are evolving, and with that, new Revenue streams e.g. pay-per-use and more.

Cyber-Physical Systems will also bring an indirect change to Key resources, Key activities, and Key partnerships as a complex and dynamic market asks for more advanced solutions only possible through cooperation amongst suppliers. Also, to stay competitive it is established that an increased focus on core competences is at hand, ergo, changes to Key resources and Key activities.

To summarize, the business model of tomorrow is assumed to undergo a transformation in six out of nine blocks in the business model based on Cyber-Physical System utilization, see figure 12, changes marked in grey.

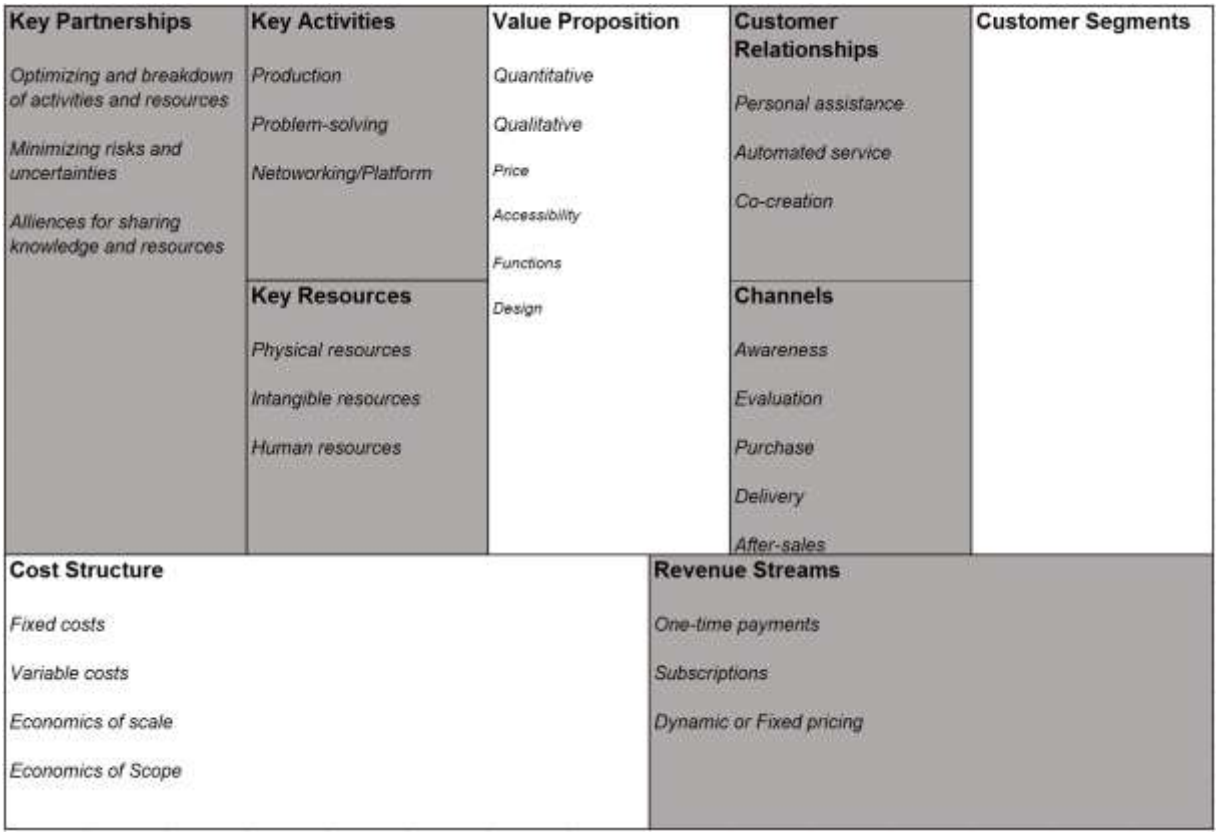

Figure 12: The changes in business models deriving from Cyber-Physical System utilization.

6.4. Business Model development and CPS

Based off the other three research questions, recommendations can be presented for how business model generation and innovation should be done to benefit from Cyber-Physical Systems.

The biggest change to expect regarding business model is anticipated to regard key partnerships. Even if an organization approaches a digitalization with only internal ambitions, it is recognized that partnerships is needed to ensure that a highly automated and digital production is possible. If an organization instead focuses on external aspects when approaching a digital transformation, it was shown that collaborations is needed to ensure that the company stays competitive and delivers maximum value to their customers. Therefore, the conclusion can be drawn that key partnership are to be given more focus in the future and it may not be suitable to define key partnership second last, as for now. Moreover, key partnerships erupt not only based of the value-package, but also dependent on how core competences are approach in the organization, therefore, as in some cases with Lean canvas, may key resources and key activities (i.e. parallels to core competences) be elaborated on together with key partnerships instead of after each other as for now.

7. Discussion

7.1. Findings and Future research

The result of this thesis was highly affected by the partition seen amongst the respondents. One group had a very internal focus when discussing the digitalization (the Settler), another group had instead an external focus (the Reacher). Even though this thesis, and especially the sample, is too small to draw any conclusions upon about this partition, an explaining pattern was seen. Those respondents whom focused on internal aspects mostly worked in manufacturing firms coupled to heavy industries. Therefore, to elevate and strengthen the findings of this research it is suggested to conduct research on how CPS utilization affects business models in heavy industries i.e. steel industry, paper and mill industry, and more; but also how it affects industries producing smart products respectively.

The utilization of CPS was a central part of this thesis, however, the thesis lacked regarding the level of technical focus, as it was focused on the impact CPS had on Business Models rather than CPS themselves. The result showed a very disruptive CPS utilization, as well as an implementation of CPS which differed with every respondent. Hence, research should be conducted with the purpose of testing the 5C architecture to ensure that it is fit for the manufacturing industries of today. Also, it should be studied if the 5C is used for implementations done recently and if the disruptive CPS utilization was founded long ago, before a fitting implementation architecture was developed. Furthermore, future research regarding CPS utilization and implementation should also focus more on internal aspects of a business model such as; cost structure, key resources, and key activities to elevate the findings of this study, which were more related to the external aspects.

It was also established that some parts of the business model are expected to change as a direct result of CPS utilization. First and foremost, it is clear that partnerships and collaborations will play a more important role in the future, digitalized, manufacturing industry. Future research should therefore be conducted with the aim to establish how these partnerships will look and what the ambition of these collaboration is, for all involved parts. It was also established that more focus will be put on core competences, however, in the BMC figures it as key resources and key activities, research should be done to determine if the division between resources and activities are necessary or if core competences should be embraced to fit the practitioners more.

Also, as IBM's CBM is developed with specialization in mind, the five dimensions of a business component (see figure 6) may be a fit concept for determining which competences that is core competences and which are not.

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Appendices

Interview guide

This section is conducted with the purpose of describing the structure, questions and other guidelines used when the interviews were conducted. The interviews were of a semi-structured nature with some more general topics and some more specific questions.

Formalities

- The interview should start with the interviewer clarifying the purpose of the interview and ask the interviewee for the consent to record the interview.
- If the interviewee wants to be anonymous, that is possible. However, if so, a short description of the interviewee's title is needed e.g. *Chief of Operations at Large Swedish firm*, this to ensure that the interviewee is of interest for this study.
- All interviews will be summarized and sent back to the interviewees. This is to strengthen the findings but also to provide the respondents with a chance to make sure they were interpreted correctly.

Definition of terminology

Business Model:

A business model is a company's definition of how they create, deliver, and capture value. For this study and interviews the focus lies on; Value proposition, channels, customer relations, and key partners. However, the importance of revenue streams is also acknowledged as it may be connected to the service-/product-dominant logic.

Cyber-Physical Systems:

Cyber-physical systems refer to the integration of computation with physical processes. It is a term for describing all sorts of embedded systems which acts in a network, monitoring and controlling physical processes, usually with feedback loops where computational data affects physical processes and vice versa.

Key benefits of Industry 4.0

Industry 4.0 is said to be the fourth industrial revolution, made possible by CPSs, which in turn have made data available. The real benefit is both internal and external as this data can be used to optimize internal decision-making or creating value external to and through customers. New technologies have made it possible to gather information which until now was unavailable. As products are getting "smart" you can monitor, control, optimize, and automate products to a whole new degree and this opens up for new creative ways for creating, delivering, and capturing value.

Interview topics and questions

General questions and introduction

- What does a digitalization of the company mean to you?
- What is a smart product by your definition?
- Can you walk me through the company's biggest digital transformation so far and what the purpose of it was?
    - If no transformation has been done, why is that?
    - What would you like to see in the future?
- How does the company utilize smart products and machines right now?
    - How is it planned to further embrace capabilities of smart products?

Cyber-Physical Systems

- Does the company utilize cyber-physical systems?
    - In the products?
    - In the machines?
- Based on the companies use of CPSs, what is the goal? (why are machines/products smart and connected?) is it:
    - Monitoring?
    - Controlling?

    - Optimizing?
    - Automate?

- Has the company taken any steps towards a new level of data utilization? As example the theories mentions:
    - Gathering data from physical assets which until now has been impossible?
    - Combining data across industries
    - Trading (selling/buying) data

- Do the company utilize the so called "product cloud" – Where parts of the value coupled to the products exists only through computational processes in the cloud?

Business Model

- Based on the company's digitalization and use of CPSs, has any change affected your business model? Has there been any change in:
    - The value proposition? (i.e. How you make money?)
        - E.g. any new services?
        - New products?
        - New data utilization?
    - Distribution channels?
    - Key partners?
        - Any more evolved and elaborated collaboration with any other actor?
    - Customer relationships?
        - How do you approach your customers and how is the relationship built?
    - Cost structure and revenue streams?
        - Do you charge any different?

        - Have the company noticed a significant change in costs?

- If there are no specific change to any of the above stated aspects, why not? Why isn't there any change?

- How does the company approach the aspect of transparency?

    - Based on the new possibilities of integration and the change towards a network approach instead of the producer/customer approach?

- How is the company going to embrace the benefits of its digitalization?

    - Can you describe the smart factory of tomorrow with your own words?

Interviewees

Below are the respondents introduced in a chronical order together with their position at their company. The interviews were in average 55 minutes long and done over the phone except for the interview with Magnus which was done face-to-face.

- Lars Celano – Chief of Technology at Mitsubishi Electrics Sweden.

- Thomas Stetter – Regional manager for the Digital Factory at Siemens

- Johnny Lundberg – Project manager at Cambrex

- Niklas Wass – Chief of Operations at Outokumpu

- Jan Tegevall – Sales Manager BoschRexroth

- Andreas Rosengren – Consultant at Prevas

- Magnus Bårdén – Executive Officer Compare Karlstad