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Value Creation in the Internet of Things Ecosystem

A study of how to control and leverage the value generated by connected devices

Master's Thesis in the Master's Programme
Entrepreneurship and Business Design

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Gothenburg, Sweden, May 23rd, 2018

Marcus Andersson Johan Wiklund

Abstract

The internet of things (IoT) is one of the top ten innovations that will have the greatest impact on the economy in the coming years. The IoT is predicted to reshape industries and create new competitive dynamics. For industrial firms, the IoT will enable new value offerings and collaborations. In addition, the IoT will reduce industry borders, increase market competition, and value creation will most likely occur in an ecosystem between several actors. With increasing competitiveness, control of value drivers will be essential in order to stay competitive.

Intellectual property rights have traditionally been one of the key elements to profit from innovations. Further, patents have been seen as one of the strongest tools to create control positions. However, the patent law was created before the age of digitisation and patented software has been hard to enforce against infringers. This has led to questions of how firms can create control positions within an IoT context. Therefore, the aim of this study is to provide tools for firms to identify, control and leverage values generated by IoT ecosystems.

To fulfil the aim of this study, a case study was conducted. Two cases were chosen, the Tork EasyCube, a smart management system for restrooms, and the Bosch IoT Cloud, Bosch's overall service for IoT devices. This study identified that the value generated in an IoT ecosystem can be divided into five categories; cost structure, revenue model, economic benefits, control, and competence. Each of these values can be used to attract participants to an IoT ecosystem. In order to leverage the values on the market, a firm has to assess the values from a firm-, customer- and collaboration-perspective. This study showed that to obtain control within an IoT context, firms have to use different IPRs as building blocks in combination with different elements of market power and technical control. A firm can leverage IoT generated values by either controlling the entire value chain or by using a more open business model. By controlling the entire value chain, a firm has high level of both control and potential of monetization. On the other hand, by providing its IoT solution as a more open business model, e.g. a platform, a firm can gain fast scaling and gain lock-in effects of customers. This as platforms enable value creating activities which are based on interactions of actors from different industries. Such offerings are hard for competitors to match. However, increased openness brings challenges. This study points out that a firm has to manage two main challenges. These are ownership of data and the risk of confidential information leakage.

Keywords: *internet of things, intellectual property, intellectual assets, value driver, control, IoT ecosystem, business model, case study, collaboration, leverage, competitive advantage.*

Abbreviations

API	Application Programming Interface
AWS	Amazon Web Services
B2B	Business to Business
DCU	Data Communication Unit
DRM	Digital Rights Management
FRAND	Fair Reasonable And Non-Discriminatory
IaaS	Infrastructure as a Service
ICT	Information and Communications Technology
IoT	Internet of Things
IPRs	Intellectual Property Rights
M&A	Merge and Acquisition
OS	Operating System
OSGI	Open Service Gateway Initiative
PaaS	Platform as a Service
PTC	Parametric Technology Corporation
SaaS	Software as a Service
SCU	Sensor Communication Unit

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1. Introduction

The introduction chapter starts by introducing the internet of things as a phenomenon and how it creates new business opportunities and challenges for firms. Thereafter the problem definition, the purpose, the research questions, and the scope and delimitations of this study are presented.

1.1 Background

The internet of things (IoT) is ranked as one of the top ten disruptive innovations that will have the greatest impact on the economy in the coming years (Bisson et al., 2013). Although the IoT term did first appear in year 1999, it is not until recently it has gained increased attention (Wielki, 2017). The IoT refers to the use of sensors and communication technologies, so called automatic identification and data capturing technologies. These technologies are integrated into physical objects. Thereby, physical objects gain intelligent characteristics which enable monitoring of the objects (Aharon et al., 2015, Papert & Pflaum, 2017). The concept of the IoT provides huge opportunities for modern organisations to strengthen their competitiveness. New business models based on connected solutions have been shown to destroy traditional industries where physical products are in focus (Wielki, 2017). Therefore, for industrial firms, which sell non-digitised products, the IoT will mean changes to their existing business models, operations and value propositions. As products become intelligent, new ways of creating value for customers evolve and relationships between industries and customers turns around. For industrial firms to survive, it will not be enough to offer physical products only. Instead, firms have to create relationships with their customers and capture their wishes and needs at the planning stage (Sendler, 2018). That will be possible through digitalisation and with the emergence of the IoT. Sendler (2018) as well as Petrusson (2005) state that the future belongs to a sharing economy and the need of capital will gradually recede. Entry barriers to industries will be reduced and it will become easier for new players to enter and impact existing markets.

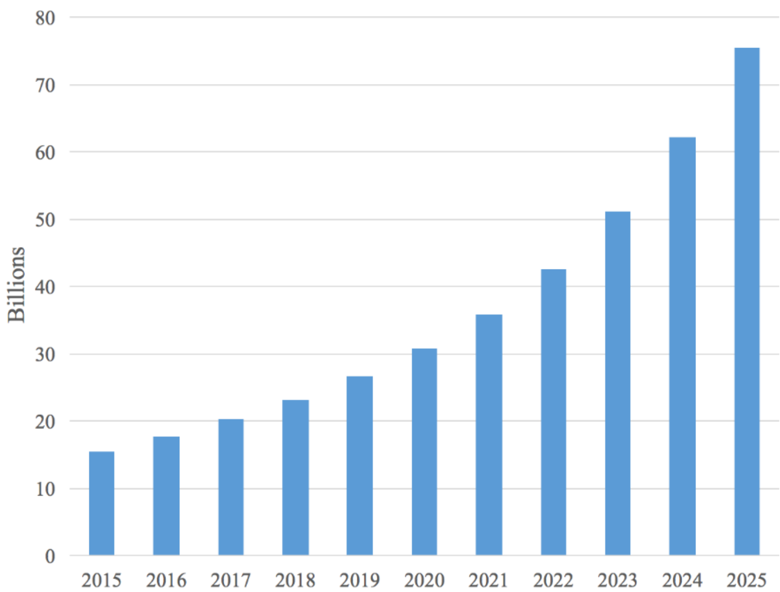

Figure 1. Illustrates number of connected devices predicted to be installed worldwide from 2015 to 2025 (in billions) (Statista, 2018).

To compensate for increased competition, firms will have to change their business models (Sendler, 2018). Instead of having a closed product-centred business model, industrial firms have to develop a more open-oriented business model. A model that favours collaborations and becomes customer-centric. An open business model enables easier connections between devices. Hence, new type of customer offerings can be developed. Such offerings are hard for competitors to copy. However, to realize opportunities and to successfully transform a business model is not easy. The level of success depends on employees' acceptance and willingness (Buschmeyer, Schuh, & Wentzel, 2016). In addition, an open business model will most likely mean that a firm has to collaborate and be part of an ecosystem (Banerjee et al., 2014).

The increased digitalisation of economies brings challenges to identify and control generated values. Patents have traditionally been seen as one of the strongest tools to create a position of control. This as patents allow patent holders to exclude others from undertaking patented activities. However, the patent law was created before the age of digitalisation. In addition, patented software has been hard to enforce against infringers. Therefore, challenges of using patents for controlling software have emerged and increased during recent years (Spinello, 2007). To create a control position in a digitised economy, it is critical that a firm has knowledge of which assets that the firm possesses (Petrusson & Pamp, 2009). In addition, a firm also has to have the capabilities of turning its assets into tradable objects.

1.2 Literature review

In the beginning of this study an in-depth literature review was conducted. The purpose of the literature review was to explore what previously had been written within the area of the IoT and how firms can leverage IoT generated values. That meant that the authors were able to identify which concepts that were developed and what had been written before in the field of research (Bryman & Bell, 2015). The literature review brought the authors an understanding of the research topic as well as it influenced the scope of this study. This as the literature review identified previous research and what theory that was available in order to fulfil the aim of this study.

1.3 Prior research

The literature review enabled the authors to conclude that there are three main areas of the IoT where prior research has been conducted. These are changing business models, changing value creation and changing control mechanisms.

1.3.1 Changing value creation

The phenomena of collecting and analysing data provides the potential to offer business value that goes beyond operational cost savings (Aharon et al., 2015; Banerjee et al., 2014). The IoT creates opportunities for more dynamic industries and new ecosystems. The term "data is the new oil" has widely been used during recent years. The term refers to data as the new way to guarantee growth and profit (Feldmann, Hartmann, Zaki, & Neely, 2016; Rotella, 2012). Data from connected devices constitutes valuable source of direct and accurate information that can be further analysed to decide how to act or react (European Patent Office, 2017). To take advantage of collected data, managers and executives are required to truly embrace data-driven decision making (Aharon et al., 2015). In addition, managers have to understand that the value creation in an IoT environment, will most likely occur in an ecosystem between players located at different operational layers (Banerjee et al., 2014). The emerging changes in value creation makes this subject relevant to further research.

1.3.2 Changing business models

Wielki (2017) explains how the IoT enables firms to offer their products as services instead of as physical products only. Turber, Brocke, Grassman, and Fleisch (2014) add to this and state that the use of digital technology in physical products change customers' perceptions of values. Due to these changes, industrial firms' business models will have to change. Instead of the traditional firm-centric approach to how value is created, the value creation process in an IoT context is more like an ecosystem (Turber et al., 2014). With the IoT and the changing dynamics of markets, value chains will be disrupted. These factors force existing firms to rethink their methods and business strategies. Industry borders fade and new types of collaborations across industries emerge. The issue of understanding how the IoT's development affect business models makes the subject highly relevant to be further analysed.

1.3.3 Changing control mechanisms

Intellectual property rights, namely patents have traditionally been seen as one of the strongest tools of firms in order to use to create a control position. This as patents allow patents holders to exclude others from undertaking patented activities. However, patented software has been hard to enforce against infringers (Robinson, 2015). Courts often argue that software achieves abstract ideas only. Furthermore, the IoT technology is interactive and collaborative. Therefore, patent infringements are often undertaken by multiple infringers (joint infringements). That makes the legal processes difficult. In addition, when developing software, agile methods are used. Agile ways of working affect the possibility to protect methods through patents (Millien & George, 2016). Altogether, the issues of software patentability, new methods of working brought by the IoT, and increasing challenges for firms to protect and control digitised products, makes the control focus of the subject highly relevant for this study to further examine.

1.4 Problem definition

The emergence of the IoT reshapes business dynamics and competition of industrial firms. To compensate for increased competition, industrial firms will have to change their business models (Sendler, 2018). Instead of using product-centred and closed business models, industrial firms have to transform their business models to become more open. This transformation will impact where and how value is created. In addition, increasing connectivity brings concerns of how a firm can protect an IoT solution. Despite prevailing studies conducted on the IoT and connected devices, there is a notable need for an in-depth analysis on how to control and leverage IoT generated values. The literature review did not identify one single theory that could provide a theoretical framework which allowed for an in-depth and holistic analysis of how firms can control and leverage IoT generated values. However, the literature review identified theory that could be combined in order to provide such an analysis.

1.5 Purpose

Based on the problem definition, the potential of combining different theory in order to provide an in-depth and holistic approach to how IoT generated values can be controlled and leveraged calls for further research. Therefore, the purpose of this study is to identify theory than can be combined to provide tools in order to identify, control and leverage values generated in IoT ecosystems.

1.6 Research questions

To fulfil the purpose of this study, the following main research question has been formulated:

MRQ: How can the value generated in an IoT ecosystem be controlled and leveraged?

To answer the main research question, the question has been further broken down into two additional research questions. The two sub-questions are as follows:

RQ1: What values are generated in an IoT ecosystem?

The objective of the first sub-question has been to identify what type of values that are generated in an IoT ecosystem.

RQ2: How can a firm leverage the value on the market through different control mechanisms?

The objective of the second sub-question is to examine how firms can use control mechanisms in order to leverage IoT generated values on the market.

1.7 Scope and delimitations

The aim of this study is to identify theory that can be tested in order to identify values in an IoT ecosystem and how they can be leveraged on the market through control mechanisms. In order to do this, the developed theoretical framework was tested on two cases. This study does not include considerations in relation to personal data storage, regulations or financial matters.

2. Methodology

This chapter outlines and explains how this study has been conducted, research methods used and how validity and reliability concerns have been managed. The chapter includes the following sub-chapters; research strategy, research design, data collection, research process, and quality of research.

2.1 Research strategy

The following sections will highlight this study's research strategy. A research strategy helps to explain the link between theory and research (Bryman & Bell, 2015). The link between theory and research in this study is highlighted in the following sub-sections of *theory and research, qualitative strategy,* and *triangulation.*

2.1.1 Theory and research

The purpose of this study includes both identification and testing of theory. This makes the relationship between theory and research both inductive and deductive (Bryman & Bell, 2015). Inductive as different theory is identified in order to create new theory, and deductive as produced theory is tested. This relationship between theory and research in this study can be explained as inductive theory-building (Eisenhardt & Graebner, 2007). The theory used in this study can be explained as middle-range theory. According to Bryman & Bell (2015), middle-range theory is domain specific and vary depending on research purpose. For this study, therefore, theory has been selected according to achieve the research purpose. The theory used in this study is further explained in the section of theoretical foundation.

To find relevant theory to this study, the field of research was explored by the literature review. This as an explorative approach toward literature is convenient for conducting research within relative unexplored topics (Denscombe, 2010). As mentioned above, no single framework or theory was found in order to fulfil the purpose of this study. However, by identify and combining different theory, the aim of this study was fulfilled.

The combination of theory in this study can be explained as the development of a concept (Lynham, 2002). That means that the authors of this study first constructed a theoretical framework. The framework was then operationalized (Lynham, 2002). For this study that meant that the different parts of the theoretical framework were partly tested and the results were discussed with persons considered to be experts within the respective field of testing. The operationalization part brought insights of how the theory had to be changed. After the operationalization phase, the framework was once again tested in practice in order to verify outcomes with experts within the field of research. This phase concluded that the constructed theoretical framework was applicable (Lynham, 2002). Thereafter, the theoretical framework was fully tested in practice in order to confirm or to disconfirm the usefulness of the framework (Lynham, 2002). That was done by applying the framework to a specific case were the results were discussed with persons having specific knowledge of the case. These persons confirmed the theoretical framework and its applicability. During the testing process, new insights were gained which were incorporated into the framework. Finally, the amended theoretical framework was applied to the reference case once again as well as to a second case.

In order to test this study´s theoretical framework, the epistemological orientation has been positivistic (Bryman & Bell, 2015). This as the theory has been tested in order to confirm or disconfirm theory. The ontological consideration in relation to this study´s theory is objectivism (Bryman & Bell, 2015). This as the study´s theoretical framework approaches the the subject matter as if it was an objective entity.

2.1.3 Qualitative strategy

In order to test this study´s theoretical framework, this study´s empirical data has been collected by using a qualitative research strategy (Bryman & Bell, 2015). The aim of the collected data has been to develop the theoretical framework and not to generalize the results. Further, this study is based on qualitative data as the study calls for a high level of detail for testing chosen theory. According to Denscombe (2010), that allows the research to reveal more information with higher level of detail (Denscombe, 2010).

2.2.2 Triangulation

To allow for a more complete understanding of the studied subject matter as well as to increase the quality of findings (Denscombe, 2010), this study has used different data collecting methods. That allowed for methodological triangulation (Denscombe, 2010). The purpose of using triangulation in this study is to bring forward different perspectives on the researched subject matter. Different perspectives have been achieved by using remarkably different methods. In this study, the high difference between methods has been achieved by collecting data from case studies, documents, and interviews.

2.2 Research design

A research design illustrates the frameworks used in a study in order to collect and analyse data (Bryman & Bell, 2015). This study's research design is based on *case studies*.

2.2.1 Case studies

A case study is appropriate to use in order to gain insights of how and why something happens (Denscombe, 2010; Eisenhardt & Graebner, 2007). This study is based on two case studies in order to inductively build and test theory (Eisenhardt & Graebner, 2007). The first case served as the testing object for operationalizing, testing, applying and confirming the constructed theoretical framework. By focusing on one case as the starting point, a researcher has the potential to build better theory compared to if several cases would have been included. This as the author has the possibility to match the theory to the specific case. The second case was used in order to extend and test the verified theoretical framework. The cases were seen as independent units for analysis as the aim of this study´s inductive theory-building is to create a theoretical framework that can be replicated.

By using two cases in this study, it was possible to take advantage of qualitative insights from the first case and transform them into new theory that was tested on the second case (Eisenhardt & Graebner, 2007). Bryman &Bell (2015) add to that as a case study with several cases improves theory building and puts the research in a better position to identify circumstances why theory does or does not hold. Further, a case study research design contributes to create a better understanding of the studied social phenomena (Bryman & Bell, 2015).

As the theory used in this study was identified and combined into a new theoretical framework, the theory built in this study is extended from previous research. The purpose of extending the theory in this study is to provide an in-depth and holistic approach towards the research subject matter. From a theory perspective, that enables refinement and improvement of existing theory (Eisenhardt & Graebner, 2007).

The two cases were selected based on theoretical sampling. That means that the cases were selected as they were found to be suitable for theory testing and theory building. In addition, the cases were selected because they did represent different examples which can be seen as extremes when compared to each other. That facilitates pattern recognition between the two cases and contributes to increase the replicability of this study´s produced theory (Eisenhardt & Graebner, 2007).

2.3 Data collection

The inductive and deductive approach of this study in combination with a case study research design, called for three different methods for collecting data. These are data collected from *documents, case studies,* and *interviews.*

2.3.1 Documents

Public documents such as company information, reports, conferences and press releases have been used in order to collect background information of the two cases. Further, public information has been used in order to evaluate the two cases patenting-, trademark- and design-rights activities. In addition, public documents have also been reviewed during the literature review. The majority of the literature review was conducted during the first phase of this study. To ensure that the most relevant theory was chosen and to increase the quality and level of objectivity, the literature has been revised and improved when applicable. The majority of the revisions were done before the theoretical framework of this study was established. To ensure that the highest quality of information was retrieved, the main sources of information have been collected from databases provided by Chalmers University of Technology. In more detail, the main databases used were, the Emerald, ScienceDirect, Scopus and ProQuest. Due to the novelty of the research topic, the vast amount of article publications has taken place during the last five years. In order to assess which articles that should be used in this study, two main parameters have been used. First the (1) number of citations and (2) how well-known the author(s) is within the field of research. In addition to academic sources of information, non-academic sources have been used in this study as well. Examples of such sources are white papers developed by management consultancy firms, such as McKinsey and Deloitte and articles published by the European Patent Office (EPO). Both the consultancy firms and the EPO are known of striving for high quality of content. Therefore, it can be argued that their articles and reports are of the high quality needed to be used as sources in this thesis.

2.3.2 Case studies

In order to be able to evaluate and test the theoretical framework of this study, two cases were chosen. The first case served as the main object for theory testing while the second case was studied in order to extend the theoretical framework. This to be able to make additional refinements to the framework. The two cases were selected based on theoretical sampling (Eisenhardt & Graebner, 2007). Denscombe (2010) adds to this by explaining that it is essential that cases are selected based on their specific characteristics. To select appropriate cases for this study, the cases had to have the following characteristics. First, the cases had to be practically linked to the purpose. For this study, that means that the cases had to represent industrial-firms which provide IoT offerings. Secondly, the cases were to be considered as typical units of analysis (Denscombe, 2010). Finally, to allow for a broader discussion of how IoT generated values can be leveraged, the cases were also selected to represent different business models enabled by the IoT. For this study that means an open- and a closed-business model. The selected cases are as follows:

- *The Tork® EasyCube®* - an IoT based monitoring/management system for restrooms. By connecting dispensers and logging usage, the overall management of restrooms becomes more intelligent. The product is sold as a product as a service where customers pay-as-they-use plus a monthly subscription fee.
- *The Bosch IoT Cloud* - is Bosch's holistic cloud-based solution for IoT devices. The Bosch IoT Cloud comprises of three main elements; Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

2.3.3 Interviews

Qualitative interviews have been used to collect data with high level of detail (Bryman & Bell, 2015). For this study, the interviews provided inputs of high level of detail for discussing and confirming this study's results from applying this study's theoretical framework. To enable comparisons of interviews, an interview guide was developed. The interview guide contributed to a flexible interviewing process as well as for retrieving answers to specific questions. This makes the interviews used in this study semi-structured. A semi-structured interview has defined questions but the interviewer can add additional questions during the interview. In addition, respondents are not deemed to answer the questions in a specific manner and do have flexibility in how they deliver their answers (Bryman & Bell, 2015). Notes were taken during the interviews in order to capture the interviewees' personal perspectives and to keep track of all information exchanged during the interviews. Summaries of the interviews were written within a day after the interviews were completed. That ensured a thorough analysis of the interviews and made it easier to compare the interviews. The interviewees were selected based on the following criteria (1) their experience within the field of research, (2) job assignments in relation to the topic of this study and (3) the interviewees' availability for interviews.

2.4 Research process

This section outlines the overall research process and explains the methods used in each phase of the study. The study can be divided into three main phases. The first covers the background study where the researchers gained a deeper understanding of the issues and challenges of the topic as well as identified relevant theory. The background study, together with the theory building part constitute the foundation of this study's developed theoretical framework. The theory building represents the transition process from phase one into phase two. Phase two continued with theory building and also represents the process of conducted research. The conducted research, first included testing of the theoretical framework by applying it to the Tork EasyCube. By comparing the results from testing the theoretical framework with data gathered from interviews, the theoretical framework was further developed. The theoretical framework was then applied to the Tork EasyCube once again. Thereafter the theoretical framework was applied to the Bosch IoT Cloud. The third and last phase of this study covers the analysis, result, conclusion and discussion as well as finalising the thesis. The research process can be seen in *figure 2*.

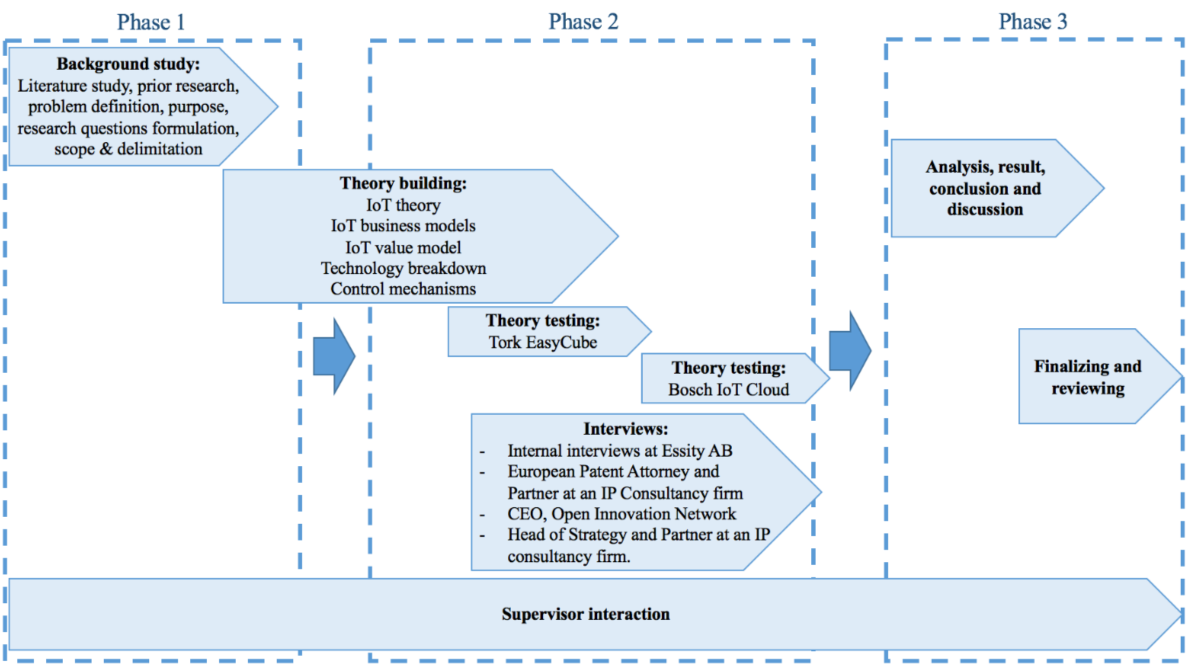

Figure 2. Illustration of the research process.

2.5 Quality of research

People perceive and interpret things differently, it is therefore important to question a study's gathered material (Patel & Davidsson, 2003). The main purpose of questioning the source of data is to challenge how data has been collected and compiled. If the source of data is of poor quality or is incorrect, the result will be of low quality or false. This phenomenon is referred to as "garbage in, garbage out" (Edvardsson, 2009). This study is a qualitative study and in a qualitative study the concerns relate to words rather than numbers (Bryman & Bell, 2015). It is extremely important to question the sources of data and to use reliable sources only to achieve high quality. To achieve high quality of data, three parameters have been in focus when conducting this study. These parameters are *reliability, validity* and *trustworthiness.*

2.5.1 Reliability

The consistency of measuring a concept is referred to as reliability (Bryman & Bell, 2015). Bryman & Bell categorise reliability into two main categories, *internal* and *external.*

2.5.1.1 Internal reliability

Internal reliability refers to how the researcher interprets the collected data (Bryman & Bell, 2015). In more detail, if the result would be the same if the used data was processed again. To reach high internal reliability of this study, both authors as well as supervisors have controlled the data used in this study. In addition, when the authors have gained additional knowledge of the studied subject matter, information and data used have been revised. Finally, to increase the internal reliability, supervisors and opponents have continuously taken part of discussions of how the study proceeded.

2.5.1.2 External reliability

External reliability refers to the degree a study can be replicated (Bryman & Bell, 2015). In a qualitative study, replication is often a challenge as settings change over time. Bryman & Bell (2015) refer to this phenomenon as stability. Most of the data used in this study has been collected by using established frameworks. To mitigate the risk of collecting case data of low-quality, only primary sources have been used. In addition, all results from interviews, cases studies and literature have been evaluated and triangulated. All the frameworks used in this study have been accompanied by thorough user instructions. There is, however, a risk that interpretations of guidelines differ among people. To compensate for that risk, both authors have studied the guidelines and the supervisor from academia has been consulted. This to discuss the authors' intentions of using the frameworks as well as their applicability to this study.

2.5.2 Validity

One of the most important criterion of a study is its validity (Bryman & Bell, 2015). Validity refers to the integrity of the author's conclusions based on the results of a study. For qualitative studies, validity can be categorised into two categories, *internal* and *external.*

2.5.2.1 Internal validity

Internal validity relates to the issue of causality. The issue of causality means whether or not the conclusions and findings of the researcher actually hold water (Bryman & Bell, 2015). For instance, if parameter x causes y, is it certain that x causes variation in y and not something else. To achieve high internal validity, this study has used highly cited and well-known frameworks with clear guidelines. In addition, external experts have been consulted through interviews to validate the conclusions made. The authors are aware of that the framework used for identifying value creators in an IoT ecosystem is relatively new. That could imply validity issues. To mitigate that risk, the background of the framework, its instructions, as well as examples of when the framework has been used have been thoroughly studied by the authors.

2.5.2.2 External validity

External validity addresses the concerns of the results applicability to be generalised beyond the specific research context (Bryman & Bell, 2015). For this study, one concern is therefore how this study's cases have been selected. As two cases only are included in the study, it can be difficult to draw conclusions which are applicable beyond the specific field of research. To mitigate the risk of low external validity, this study's cases have been strategically selected. The cases have been chosen because they have a clear connection to the purpose of the study. Further, they are considered as typical and appropriate examples for deductively testing this study´s selected frameworks and theory. To reduce the risk of low potential of generalising this study´s conclusions, the conclusions have been analysed and compared with literature, data collected from interviews and the supervisor. In addition, the results have also been discussed with experts within the field of study.

2.5.3 Objectivity

Objectivity implies whether or not the researcher's personal values have interfered when results were interpreted (Bryman & Bell, 2015). Absolute objectivity is impossible to guarantee in business research. However, to mitigate the risk of intrusion when testing the theory, the authors were guided by established frameworks throughout the entire research process. The results generated by using the frameworks have been anchored with professionals and the authors' supervisors. By thoroughly explaining the research process, the used theory and concepts, the authors' increase the replicability of this study. Such approach is according to Bryman & Bell (2015) convenient to increase a study's objectivity.

3. Theoretical foundation

This chapter presents the theoretical foundation of this study. The chapter starts with an introduction to the IoT and how it affects business environments (3.1). Thereafter, IoT based business models and the concept of value proposition are introduced (3.2). Section 3.3 introduces the IoT value model while section 3.4 explains how value layers of an IoT ecosystem can be disaggregated. Section 3.5 explains how IoT technologies can be controlled. The chapter ends by section 3.6 that describes the overall design of this study's theoretical framework.

3.1 The Internet of Things

The Internet of Things (IoT) refers to the use of sensors and communication technologies, so called automatic identification and data capturing technologies (Wielki, 2017). These technologies are integrated into physical objects. That gives physical objects intelligent characteristics and enables easier monitoring of the objects (Aharon et al., 2015; Chaouchi, 2013; Papert & Pflaum, 2017). Integrated intelligent objects connected to each other create complex networks based on three core elements: (1) smart devices, (2) data aggregation and (3) methods and systems for analysing and storing device data (Fan & Zhou, 2011). Collecting data and performing analysis of data enable business value that goes beyond operational cost savings. In addition, device data creates opportunities to establish new ecosystems and more dynamic industries (Aharon et al., 2015; Banerjee et al., 2014). The IoT and digitalisation reduce borders between industries, companies, and technologies. That leads to new business opportunities, see *Figure 3.*

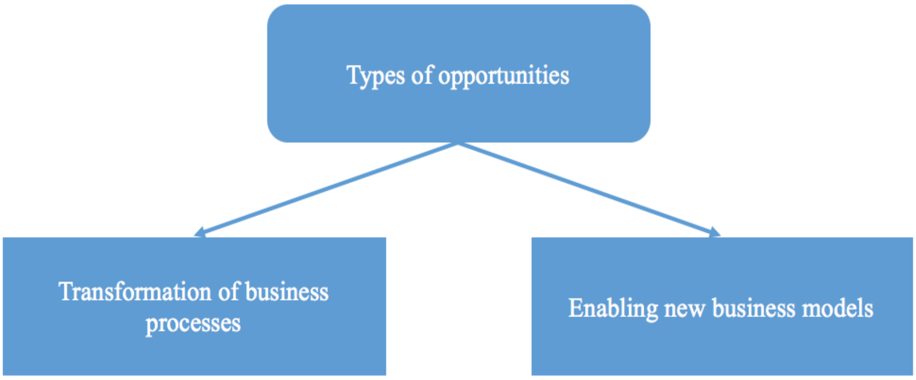

Figure 3. Illustrates two different opportunities which connected devices and IoT provide (Wielki, 2017).

Wielki (2017) explains how the IoT and data collection will enable new value propositions. Firms will be able to offer their products as services instead of selling them as physical products only. Heppelmann & Porter (2014) add to this and explain that the IoT and changing business environments will disrupt value chains and forces existing companies to rethink their methods and processes. For firms to realize the opportunities of emerging business models and the potential of the IoT, firms have to collaborate and become parts of IoT ecosystems (Banerjee et al., 2014). An ecosystem is defined as a complex web of interdependent agents and relationships between components such as technology, industries and people (Shin & Park, 2017). By taking part in IoT ecosystems, firms have greater potential to drive increased business value and to increase data sharing capabilities. By sharing data, IoT ecosystems can attract specialised participants which can use data to generate additional customer value.

3.1.1 Cloud computing

The IoT will enable new service offerings. Service offerings in the era of digitalisation are closely linked to cloud computing (Hao & Helo, 2018). Cloud computing can be defined as computed resources located and stored on a provider's server. The computed resources can then be accessed by customers on demand through the internet (Hao & Helo, 2018). Cloud computing typically falls into three groups of service offerings (1) Software as a Service (SaaS), (2) Platform as a Service (PaaS) and (3) Infrastructure as a Service (IaaS), see *Figure* 4. Each offering includes different degrees of engagement and contribution by the customer and the provider.

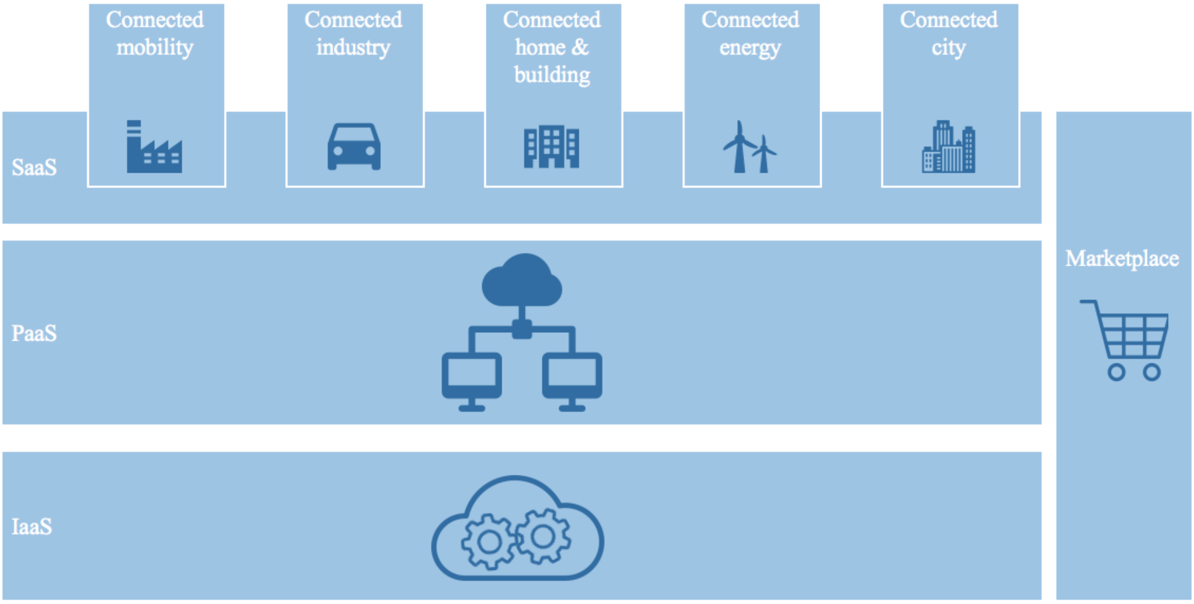

Figure 4. Three different groups of service offerings enabled by the IoT (Bosch, 2017; Hasanzadeh, Safari & Safari, 2015).

Software as a Service (SaaS) provides customers with access to software services via the internet (Hasanzadeh et al., 2015; Patel, Seyfi, & Jaradat, 2011). SaaS is the most widespread and applicable cloud-based service and includes value propositions such as pay-as-you-use or pay-per-month. SaaS often contributes to reduce costs and fixed-capital of customers. The SaaS provider is responsible for all the parts needed in order to deliver the service to the customer. Customers, on the other hand, only interact with the software service and manages data. An example of a SaaS, is a connected device that alerts customers of what and when to do certain tasks.

SaaS provides firms with high computational power and enables firms to gain a greater understanding of its operations and customers (Patel et al., 2011). That means that SaaS often has impact on a firm's decision making. Especially for adaptation decisions where SaaS is considered to deliver its highest value.

Platform as a Service (PaaS) is defined as a cloud-based service that allows customers to develop, run and manage applications on a platform (Farouk, Yousif, & Bakri Bashir, 2015). The platform infrastructure is controlled and managed by the provider of the platform. However, customers and developers may have control of applications deployed on the platform.

Infrastructure as a Service (IaaS) is a service offering where the infrastructure such as virtual storage, machines, data-sets and servers are provided to customers via the internet (Hasanzadeh et al., 2015). IaaS facilitates the parts needed in order to deliver both SaaS and PaaS. An IaaS provider manages the infrastructure and offers customers support and services.

3.1.2 Data-driven value creation

The term "Data is the new oil" has widely been used and spread during recent years and refers to data as the new way to guarantee growth and profit (Feldmann, Hartmann, Zaki, & Neely, 2016; Rotella, 2012). Data is the main feature of connected devices and is a valuable source of direct and accurate information. That information can then be analysed and used to gain recommendations of how to act or react (European Patent Office, 2017). Data generates new values which can be leveraged and used to gain competitive advantages (Feldmann et al., 2016). The retail industry is one example where data is leveraged to create new values. For instance, by analysing behaviours of customers, retailers can adjust prices and target promotions.

In order to take advantage of data collection, managers and executives have to embrace data-driven decision making (Aharon et al., 2015). Aharon et al., (2015) mention seven key areas where data can be used to add value to firms:

1. *Analytics*
2. *Cost reduction and efficiency*
3. *Realization of physical system*
4. *Software and data driven innovation*
5. *Risk reduction*
6. *New ways of distributing and storing data*
7. *Business transformation*

According to Brown, Kanagasabai, Pant, & Pinto (2017), firms which use data strategically and analyses behavioural insights, outperform their competitors. Such firms have been able to achieve 85 percent higher sales growth and 25 percent higher gross margin compared to competitors which do not use data.

3.1.3 Data-driven value chains

The IoT will impact value chains and firms that do not respond accordingly are at risk (Brock, Dreischmeier, & Souza, 2013). The IoT enables firms within one sector to become more agile and play important roles in other sectors for delivering their products and services. The fading boundaries between industries and more agile firms, change competitive dynamics of markets (Brock et al., 2013). As new players emerge and more data is captured and analysed, a shift in how value is created is expected to occur. This change is expected to distribute larger shares of the value to suppliers of software and analytics. Aharon et al., (2015) further state that suppliers and installers of hardware, IoT devices and IoT systems most likely will capture less value in the future. For a firm to fully understand the IoT's effects on value chains, it is essential that the firm understands how the technology and the industry will evolve.

The implementation process of the IoT, is based on three main phases. Depending on which phase an industry is within, value will be created by different IoT domains. *Figure 5* illustrates the three main phases of IoT and their value domains (Aharon, et a., 2015).

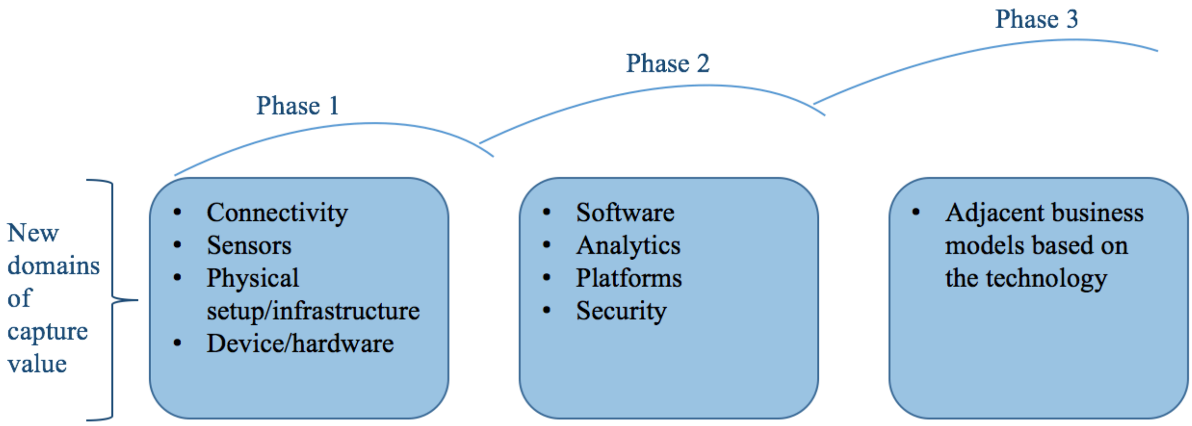

Figure 5. illustrates three phases a firm potentially could go through and what the value drivers will be in each of the three phases (Aharon et al., 2015).

It is essential for a firm to understand how the firm's strengths and strategies fit into each implementation phase of the IoT (Aharon, et a., 2015). This in order to achieve competitive advantage and to survive on the market. To achieve a control position throughout the three IoT implementation phases, a firm can become a complete-service provider (Aharon et al., 2015). That strategy enables a firm to expand its position on the market and to become more powerful in the industry. Not all firms have the possibility to become a supplier of complete services. Bughin, Catlin, Hirt, & Willmott (2018) have identified five aspects a firm has to manage in order to succeed when implementing the IoT and related services. First, (1) a firm has to create a clear definition of its digital strategy. Data enables new ways of analytics and those should be used by firms to create new competitive advantages. (2) Understand the economics of digital. On average, digitalisation creates more value to customers than to the firm itself. Digital often cut prices and firms have to understand how to compete and to create novel values for customers in order to stay competitive. In addition, digital rewards first movers and superfast followers. Hence new ways of agile development give the first mover a learning advantage. A first mover often has the possibility to cut costs or to release new versions of its services before followers have launched their first version (Bughin et al., 2018). The first mover's information advantage, makes it possible to understand how the market will develop. (3) To stay competitive, a firm has to understand the complete IoT ecosystem and its participants and how competitors are expected to emerge. (4) Identify new B2B opportunities. This as the IoT will enable closer collaborations between businesses. Finally, (5) managers have to understand the degree and the pace of change digitalisation brings and how it affects the firm's current market situation.

3.2 Business models

The IoT enables new type of business opportunities and new type of business models. A business model explains how an organisation creates and delivers value (Osterwalder & Pigneur, 2010). Therefore, to be able to fulfil the purpose of the study, IoT enabled business models had to be identified. The following sections presents two types of IoT supported business models. These are: product as a service and platform. The section then continuous by introducing the central elements of a business model and value propositions.

2.2.1 Product as a service

One way of capturing IoT enabled opportunities, is to turn a traditional physical product into a product as a service (Northstream, 2017). A product as a service can be defined as:

> *"It is a business model, in which the enterprise sells an integrated package that includes hardware, software, connectivity, maintenance, customer support, installation and other value adding services for a recurring fee. Such a business model innovation centered around service orientation is often referred to as servitization."* (Northstream, 2017 pp. 3)

The concept of a product as a service, implies that a supplier provides a solution that has a duration that lasts beyond a single transaction. Instead, the customer is charged based on usage or/and performance. For this kind of business model, it is essential to collect and analyse user data to create value (Northstream, 2017). There are five main business aspects which benefit from using a product as a service. These are *offerings, sales, profitability and cash flow,* and *customer relationship*. Collecting user data enables offerings which are optimized according to customers' needs. Such offerings include tailored prices and specialised offerings towards its customers Thereby a firm has greater potential to differentiate its offerings from competitors on the market (Northstream, 2017). In addition, it becomes easier for a firm to gain new customers since they pay less upfront for gaining access to the service. The relatively long duration of service offerings also enables firms to build deeper relationships with customers which may lead to increased loyalty with customers. For a firm's profitability, on the one hand, service offerings generate predictable revenue streams. On the other hand, by analysing data from the service provided, the firm can optimize its operations and increase efficiency. Thereby a firm can become more cost efficient as well.

Transforming a firm to become service-based is tempting when aiming for outstanding value creation. However, the transition process is challenging and will impact the firm's organization (Jovanovic et al., 2016; Northstream, 2017). A product as a service is well suited for products with long life-cycles.

Hence, product as a service is often suitable for B2B environments. Jovanovic et al., (2016) state three main factors which decide whether or not a firm will become successful by offering its products as products as a service. These factors are:

1. *Which functions and roles does the product have with customers.* Product as a service is appropriate to offer when the service provides supporting activities to customers' core value creation processes (Jovanovic et al., 2016). In addition, a product as a service is favourable when the running costs of the product is high in comparison to its initial price of purchase. Further, product as a service is also appropriate in environments where breakdowns of the product lead to extensive costs.
2. *Environmental conditions where the product is used.* Product as a service is more appropriate in environments which are stable and predictable (Jovanovic et al., 2016). This since a stable environment makes it easier to calculate and predict the product's need of service and maintenance.
3. *Characteristics of delivery systems for products and services.* Product as a service has higher potential to become successful when a firm has direct access to its customers and to users of the service provided (Jovanovic et al., 2016).

Transforming an industrial firm to become service-based is not easy. The transformation process is dependent on the firm's employees' willingness and acceptance of transformation (Buschmeyer et al., 2016). If the process is not facilitated accordingly, the firm may be at risk. This as the transformation process may have an overall negative impact on the firm's performance (Jovanovic et al., 2016). The process of change means changes of employees' focus. Instead of only focusing on production or sales functions within the firm, employees of a service-based firm have to frequently interact with customers. There are some best practices in order to successfully transform a firm to become a service-based firm (Northstream, 2017; Jovanovic et al., 2016). First, the firm has to have a clear strategy that is strongly supported by the management team. In addition, the transformation project team has to be cross-functional, including experts within both commercialization and technology. Secondly, the transformation process should be initiated by selecting a few numbers of specific cases and customers. That to facilitate thorough testing and a stepwise adaptation process.

3.2.2 Platform

Platform as a business model is used to connect people, resources and organisations to create interactive ecosystems (Parker, Van Alstyne, & Choudary 2016). A platform can be defined as:

> ”*A platform is a business based on enabling value-creating interactions between external producers and consumers. The platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods,*

services, or social currency, thereby enabling value creation for all participants." (Parker et al., 2016. pp. 11)

Platforms can be deployed in all industries where information is important (Parker et al., 2016). The value created on platforms are created by multiple actors. Those actors can be producers and consumers of values simultaneously. On a platform, value is produced, co-produced, exchanged and changed at different locations at the same time.

One of the strongest advantages of platforms compared to linear value chains, is their ability to foster faster and efficient scaling (Parker et al., 2016). This as platforms do not have to only use a single firm's equity or resources to establish the entire value creating system. On platforms, the community decides which products that should be offered. This is different from linear value chains where decisions whether or not to add products are taken by gatekeepers. In addition, platforms enable to unlock new sources of value and provide new sources of supply as platforms provide a greater variety of products to customers. Through faster scaling a platform can achieve network-effects. Network-effects means that the more users that connect to the platform the more value is produced to the platform's community (Parker et al., 2016). With increased value for the platform's community, the attractiveness of the platform will increase and more users will join. To achieve network-effects, a platform must offer demand economies of scale. Demand economies of scale means that users increase the value of products and services offered to other users. Demand economies of scale are further strengthened by technological advancements on the demand side of a platform. A platform network is two-sided when both consumers and producers are involved (Parker et al., 2016). A two-sided network can lead to two main network-effects, same-side and cross-side effects. Same-side effects mean that consumers have impact on other consumers and producers have impact on other producers. Cross-sided network-effects are achieved when producers have impact on consumers and vice versa. Both same-sided and cross-sided network-effects can be either positive or negative. With positive effects, the platform can grow and with negative effects, the attractiveness of the platform is reduced.

A platform provider can be seen as a broker that facilitates matching of customers and producers (Parker et al., 2016). In exchange, the platform provider charges the users of the platform based on their transactions made on the platform. A firm has to invert to become a successful platform provider. Instead of focusing on internal activities only, the firm has to focus more on external activities. Firms which aim to use a platform-based business model, have to become orchestrators of external resources instead of concentrating on optimizing their products only.

3.2.3 Value propositions

The value proposition is one of the central elements of a business model (Osterwalder et al., 2014). The value proposition is the value a company delivers to its customer in order to satisfy their needs

(Lindic & Marques da Silva, 2011). Value propositions are created to attract customers and for firms' own internal use. One the one hand, the value proposition has impact on how the organisation works. On the other hand, the value proposition also describes activities needed in order to serve customers and collaborators in a profitable manner. In the era of the IoT, new value propositions are enabled.

3.3 The IoT value model

The evolution of the IoT is driven by two underlying trends (Varmesan et al., 2016); (1) The change of focus from seeing the IoT as a technology platform to see it as a business ecosystem and (2) shift from focusing primarily on the firm's business model to designing ecosystems as well. In such ecosystem, novel ways of creating values are enabled by connecting actors from different industries. This results in a changing business environment that is much different from traditional linear business environments. With this change, traditional business model frameworks for describing value creation in an IoT environment have shown to be insufficient (Turber et al., 2014). To solve that issue, Turber et al. (2014) conducted research aiming to design a framework that can be used to identify values created within an IoT ecosystem. The research identified four key elements which recur in traditional business model frameworks. The first element is the targeted customer (Who), the second is the value proposition (What), the third is the value chain (Where) and the fourth is the incentive factor (Why). These aspects are fundamental for business models and Turber et al. (2014) found that three of those factors are essential for constructing a new framework that is applicable to the IoT. These factors are as follows:

1. *Who* - are all the participants of an IoT ecosystem. These actors are seen as collaborators from a service-dominant logic. This as they constitute operant resources within an IoT ecosystem and can co-create value with other actors
2. *What* - identifies in which layer of an IoT ecosystem an actor provides value within. The aspect of *what*, makes it possible to identify where the value creation process, cooperation and competition take place. The *wha*t dimension can reveal that one actor both cooperates and competes simultaneously with another actor at different layers of an IoT ecosystem
3. *Why* - addresses the IoT generated value and identifies reason(s) for each collaborator to take part of the ecosystem. The *why* includes value propositions. These are categorised as monetary and non-monetary values

To increase the framework's level of detail, Turber et al., (2014) disaggregated the IoT into four different activity layers. These are: the device layer, network layer, service layer and contents layers. Based on Turber et al.'s (2014) framework, Vermesan, Bahr, Gluhak, Boesenberg, Hoeer, & Osella (2016) further expanded the framework by adding additional layers of the IoT. Vermesan et al's (2016) IoT framework includes the following components;

- *Collaboration and Processing Layer* - people and business processes, transformation decisions based on applications and knowledge
- *Application Layer* - dynamic applications, reporting, analytics and processed "smart" data
- *Service Layer* – services, multi-cloud services, analytics, mining and machine learning
- *Abstraction Layer* - data abstraction, aggregation and access
- *Storage Layer* - data integration, accumulation and storage
- *Processing Layer* - edge computing, data element analysis and transformation, analytics, data mining and machine learning. Pervasive and autonomic services are provided through machines in both "autonomic" and "smart" ways
- *Network Communication Layer* - connectivity elements, gateways, communication and processing units, wireless technologies and sensor networks, body area networks, local area networks, cellular and 3/4/5G and LPWAN for delivering information
- *Physical Layer* - devices, controllers, sensors and actuators

The values generated in each of the IoT layers are offered as value propositions to stakeholders within the IoT ecosystem (Vermesan et al., 2016). To further develop the IoT framework developed by Turber et al. (2014), Vermesan et al., (2016) broke down the dimension of *Why* even further. That in order to expand the non-monetary and monetary values into the following five categories of value;

- *Competence* - is the value generated that enables an actor to do something more successfully and/or efficient.
- *Control* - refers to an actor's aim to gain power of influence to control the value generated in order to achieve economic and/or political goals. The value is linked to market power and refers to a firm's ability to influence the price and output of a market. However, the value of control as used in the IoT value model does not as IPRs enable a firm to exclude third parties from undertaking the same activities or to offer the same solutions.
- *Economic benefits* - a value that is generated that can be quantified in terms of money. For instance, the amount of money that can be saved or generated by collaborating within the IoT ecosystem.
- *Revenue model* - is value created from a revenue stream.
- *Cost structure* - method(s) to manage and determine costs.

The IoT value model framework, originally developed by Turber et al., and further expanded by Vermesan et al. (2016), can be seen in *Figure 6*.

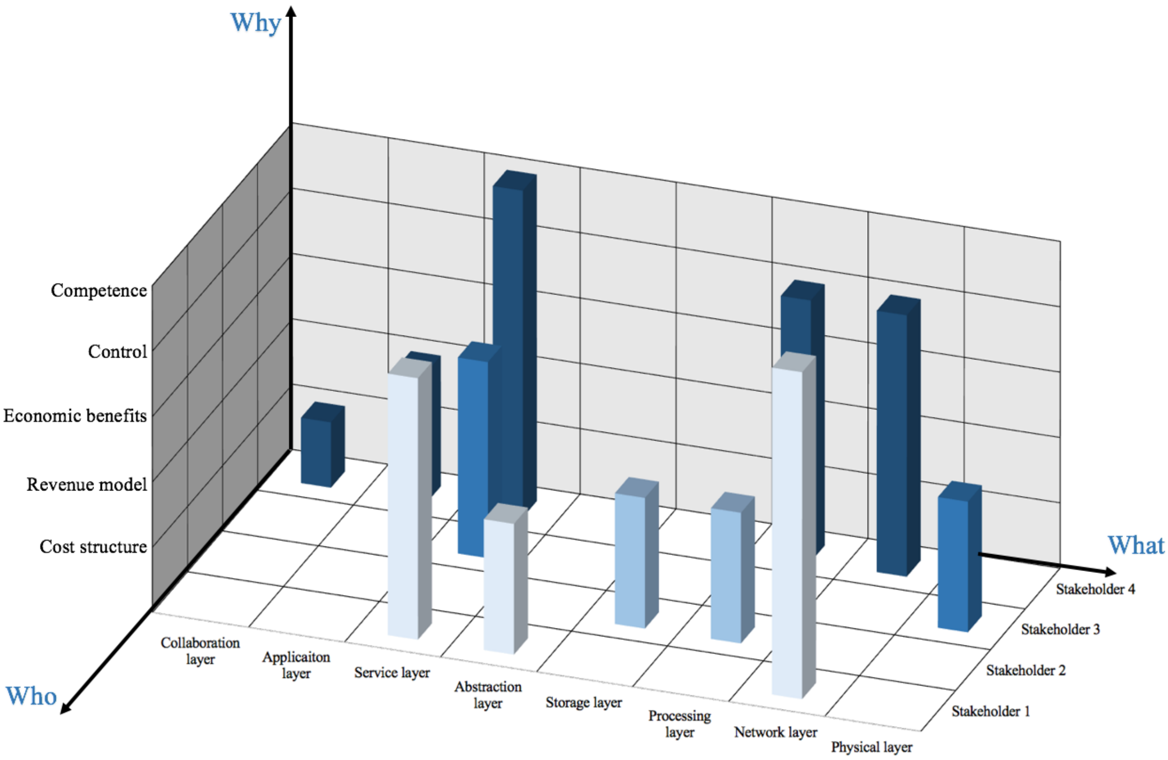

Figure 6. The IoT value model that visualizes who the participants are, in what layer the value is created and why the different stakeholders benefit from being within the ecosystem (Vermesan et al., 2016).

3.4 Technology canvas

The following chapter describes a method to breakdown technology into technology layers and core components. By understanding a technology's hierarchy and core components, it is possible to identify the technology's value-creators.

3.4.1 Technology tree

To understand what value a solution may bring and how to protect that value, the different components of the solution first have to be identified (Heppelmann & Porter, 2014). By identifying the value creating components of an IoT ecosystem, the components can be approached from a control perspective. By controlling the components, a firm can protect the value generated from competitors and copycats (European Patent Office, 2017). Thereby, a firm will be able unlock and capture the potential of the IoT and drive value creation and innovation.

A technology-tree enables visualisation of a product's technology hierarchies (Clark, 1985). Identifying a technology's hierarchy serves two purposes. The first, is to group products and technologies. The second, is to distinguish technology groups by identifying characteristics of technology differentiation. A technology tree can be used to understand where a firm has its current assets and capabilities. In addition, the tree can be used to decide what technology a firm strategically should focus on to increase its future market power (Heiden, 2017). Heiss & Jankowsky (2002) add to this and explain that in order to understand if technologies are of a firm's strategic interest, the technologies have to be evaluated.

According to Heiden (2017), *"a technology tree is a foundation for analysis and strategies development in relation to each of its' underlying fields"* (Heiden, 2017 pp. 20). A technology tree enables a firm to map out competitors' assets in relation to the firm's own assets. The technology tree can also be used as a management tool. Further, a tool for evaluating a firm's knowledge within a technology field and which technologies the firm possesses. These insights contribute to identify the firm's opportunities. It is essential to determine the firm's strategic position because actors who lack strategic positions are more likely to face higher costs of components and licensing fees. These firms are also subjects to higher risk of getting blocked or restricted in their access to technologies (Heiden, 2017). *Figure 7* represents an example of a technology tree. The example is a photovoltaic power generation system.

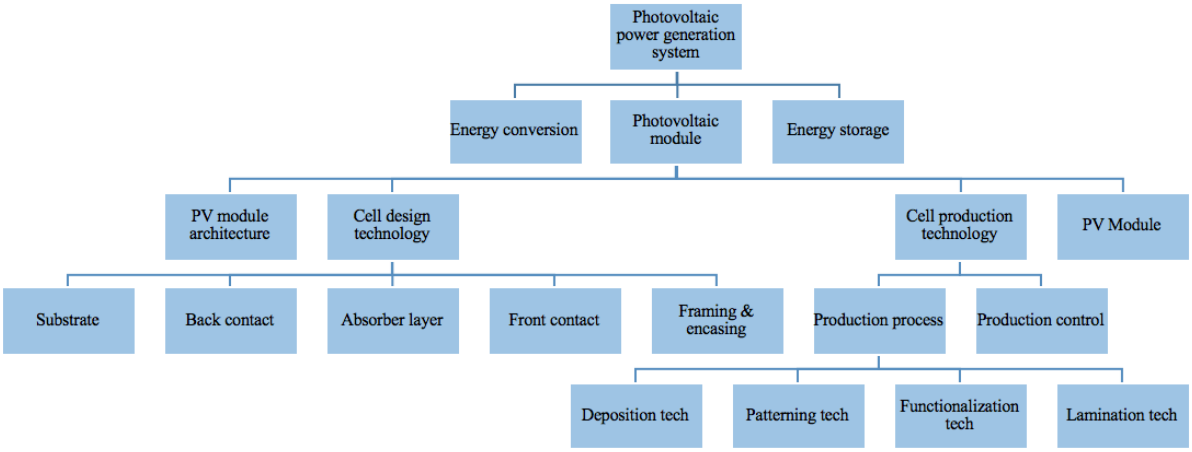

Figure 7. Illustration of a technology tree for a photovoltaic system (Bowman, 2017).

3.5 Controlling IoT technologies

Control of IoT technologies can be achieved through different mechanisms. By identifying intellectual assets, a firm can structure them in order to leverage them and create a control position on the market (Petrusson, 2004). In this study intellectual assets are group into the following building blocks: rights-based control (patents, copyrights, trademark protection and design rights), trade secrets, contractual control, technical control, and market control. The following sections will first introduce intellectual assets and thereafter the building blocks of this study will be further elaborated in the following sections.

3.5.1 Intellectual assets

Intellectual assets are assets referred to as knowledge assets which a firm can influence (Huggins & Weir, 2012). Intellectual assets are created when knowledge, know-how or learning is documented (Sullivan, 1999). Once documented, a firm can apply different control mechanisms, e.g. intellectual property-rights and/or contracts in order to control the intellectual assets. Thereby intellectual assets become resources that can convey competitive advantages (Petrusson, 2016). *Figure 8* shows categories of value-creating intellectual assets suggested by Petrusson (2016).

Categorising value-creating intellectual assets	
Creation – an artistic achievement such as painting and artwork.	*Data* – unstructured and structured data.
Database – structured and searchable dataset.	*Instruction* – description of how a task should be performed.
Narrative – interviews and literature.	*Observation* – results from an empirical conclusion e.g. trends, discoveries etc.
Software – data code.	*Technical solution* – results of how to solve a problem, e.g. invention or design.
Theoretical framework – general theory such frameworks and models.	*Visualisation* – visual representation, e.g. prototype and simulation.

Figure 8. Intellectual assets categories (Petrusson, 2016).

3.5.2 Rights-based control

Intellectual property rights (IPRs) can be used to claim ownership rights of intellectual assets (Petrusson, 2016). In this study, IPRs are defined as rights-based control. By using IPRs, an actor can claim intellectual assets and transform them into tangible objects. Such objects can then be transformed into capital and thereby create value for a firm. Further, that means that rights-based control can be used to create value for customers (McConnachie, 1997).

IPRs allow creators and owners of the rights to exploit and benefit from developed creations (WIPO, 2017). Depending on the characteristics of a creation, different IPRs can be used to establish a control position for that creation These IPRs are patents, copyright, design rights and trademark protection. Further explanations of these IPRs follow in the sections below.

3.5.2.1 Patents

Kranakis (2007) states that "*patents are tools for power and control over technology and people.*" (Kranakis, 2007 pp. 689). A patent gives the owner of the patent a temporary right to exclude others from making, selling and/or producing the patented object (Heger & Zaby, 2017). The intention of the patent policy is to ensure appropriate returns for an inventor's research and development activities. To obtain a patent for an invention, different criteria have to be fulfilled (Levin, 2011). First, the invention must include an inventive step. The inventive step is determined in relation to what is known of before and assessed in relation to what is considered to be a person who is skilled in the art. In addition, a patentable invention has to fulfil the criteria of novelty and has to be susceptible of industrial application. A granted patent provides the holder of a patent the right to exclude others from undertaking patented activities for a duration of 20 years from the patent application date. To retain a patent, a holder has to pay patent fees accordingly throughout the patent's lifetime.

3.5.2.2 Copyright

Authors and owners of literary-, musical-, architectural-, audio- and dramatic works, software and databases have exclusive rights to make copies of their work and make the work available to the public (Spinello, 2007). Copyright protection for artistic works gives protection that lasts 70 years after the death of the creator. For databases, the duration is 15 years from when a database has been compiled (Levin, 2011). In general, no registration process is required for obtaining copyright protection. However, to be protectable, the work has to fulfil the criteria of creative effort, originality and individuality (Spinello, 2007). Copyright protected work can rightfully be used by third parties for the purposes of criticism, research, classroom instructions or news reporting. There are, however, limitations to how much of the work that can be reused. According to law, quotations or minor parts of the protected work are fair to redistribute or to reuse.

3.5.2.3 Trademarks

Protection of trademarks includes protection of names, symbols and marks which ensure the holder of a trademark an exclusive right to a commercial identity (Spinello, 2007; Levin, 2011). The primary purpose of trademark protection is to hinder unfair competition from free riders taking advantage of other parties' trademarks (Spinello, 2007). The duration of protection for a protected trademark can be eternal as long as renewal fees are paid and the trademark is used. To protect a trademark, the mark has to be distinctive and graphically representable. A firm can either protect a trademark by direct registration or indirect registration through establishment.

3.5.2.4 Design rights

Design rights refer to rights to the visual appearance of a product or prototype (Levin, 2011). The holder of a design right has the sole right to exploit the design. In addition, the holder of a design right can prevent third parties from selling, importing, using and/or exporting products with designs which do not differ in the overall design compared to the protected design (Libecap & Thursby, 2008). To obtain a design right, the design must be novel and be of individual character assessed in regards to what is seen as an informed user (Levin, 2011). The duration of a registered design right varies between 10-25 years depending on jurisdiction. For unregistered design rights within the European Union, the duration of protection is three years.

3.5.3 Trade secrets

In comparison to the four IPRs described above, trade secrets are substantially different. Spinello defines a trade-secret as "*information used in the operation of a business that gives the owner an opportunity to obtain an advantage over competitors who do not know or use that information so long it's secrecy is maintained*" (Spinello, 2007 pp. 19). WIPO (2018) adds to that definition by stating that trade secrets have to be governed by non-disclosure agreements and if an unauthorized party gets hold of the secret information and use that information, that is unfair practice. As a control mechanism, a trade secret lasts as long as it is not revealed to the public. No disclosure or registration process is needed. Trade secrets do not as patents provide the holder with exclusive rights (WIPO, 2018). Instead the protection gained through trade secrets is highly dependent on trust. Once a trade secret leaks, the competitive advantage gained by keeping information as a trade secret may be lost. Even though companies use non-disclosure agreements for managing trade secrets, trade secrets have been shown to be more difficult to legally enforce compared to patents.

3.5.4 Contractual control

Contracts are in legal tradition described as *"terms of an offer and acceptance, i.e. in terms of mutual promises to sell and buy."* (Petrusson, 2004 pp. 62). For business people, contracts are often seen as a necessary evil or as a safeguarding function (Haarala, Lee, & Lehto, 2010). Petrusson (2004), however, claims that contracts are essential for claiming property rights. By using contractual tools, a firm can generate business relationships and facilitate transactions. Contracts, in many ways, function as the most important tools to construct structural order for creating and extracting financial values. In addition, contracts are important tools to strengthen a firm's control. Especially for controlling a firm's products, services and value propositions when IPRs are weak. As an example, a service-based subscription model for a software solution can be governed by contracts (Petrusson, 2004). By using contracts, the provider of the service remains in control of the software and service even though several customers have full access to the service.

The IoT, as has been stated, will reduce borders between industries and collaborations between firms will increase (Aharon et al., 2015). These changes lead to concerns of data ownership. For instance, will the data ownership be with the developer, the product provider or the customer? To capture maximum value of data and to avoid misuse of data, management of data ownership is essential. To solve data ownership concerns, contracts should be applied. In general, there are four key data concerns a firm has to manage in order to reach the full potential of digitalisation (Millien & George, 2016). These are as follows:

1. Data in relation to customers
    a. Raw data – big data collected from smart objects/devices
    b. Processed data – data generated by analysing raw data
    c. Input data – data that is entered by the end-user
2. Data in relation to manufacturers
    a. The manufacturer of smart devices owns the data regardless whether if the devices are sold or leased
    b. The manufacturer owns the data, but the customer has the right to license-in all the data
    c. The manufacturer owns the data, but the customer has the right to license-in some of the data
    d. The customer owns the data, but the manufacturer has the right to license-in the data
3. Data in relation to collaboration partners
4. Data in relation to contribution

a. Data in an IoT environment is often generated by one or several customers where different contracts may be in place. It is therefore important to keep track of who contributes with what data.

With growing digital environments and as firms become more digitised, firms will need increased software development for their IoT solutions (Millien & George, 2016). The software, will most likely not be developed in-house only by proprietary code. Instead, a firm probably has to in-license software, which often implies open source software. For open source software, it is the licensing terms of the software that determines the proprietary status of the software code and how it is controlled. In the most open setting, a user has to share its software contributions without any restrictions to external parties. Therefore, to reduce the risk that a firm loses its control of a product or a service, it is important that a firm does understand the licensing terms of an open source software before it is used.

3.5.5 Technical control

In this study, technical control refers to access control of technologies and restricting use of proprietary hardware and copyrighted works. This type of control is commonly known as digital rights management (DRM). DRM implies a firm's use of policies, techniques and tools to guide users of digital content into proper use (Subramanaya & Yi, 2006). Moreover, DRM influences the flow of digital content and, in addition, establishes rules of how and what digital content that should be encrypted. That to increase privacy and security protection of users.

3.5.6 Market-based control

In this study, market-based control is referred to as market power. Market power is defined as the firm's ability to influence the price and output of a market (Foss, Foss, & Klein, 2017). Market power can be achieved through different means and strategies. In this study, Porter's five forces is the starting point for how a firm can evaluate and establish market-based control.

3.5.6.1 Porter's five forces

According to Porter (1980), the competitive edge of a firm and the market competition, are determined by five basic competitive forces, see *Figure 9*. If a firm uses and creates its business strategy based on the five forces, the firm will become more profitable and strengthen its market power (Porter, 1980).

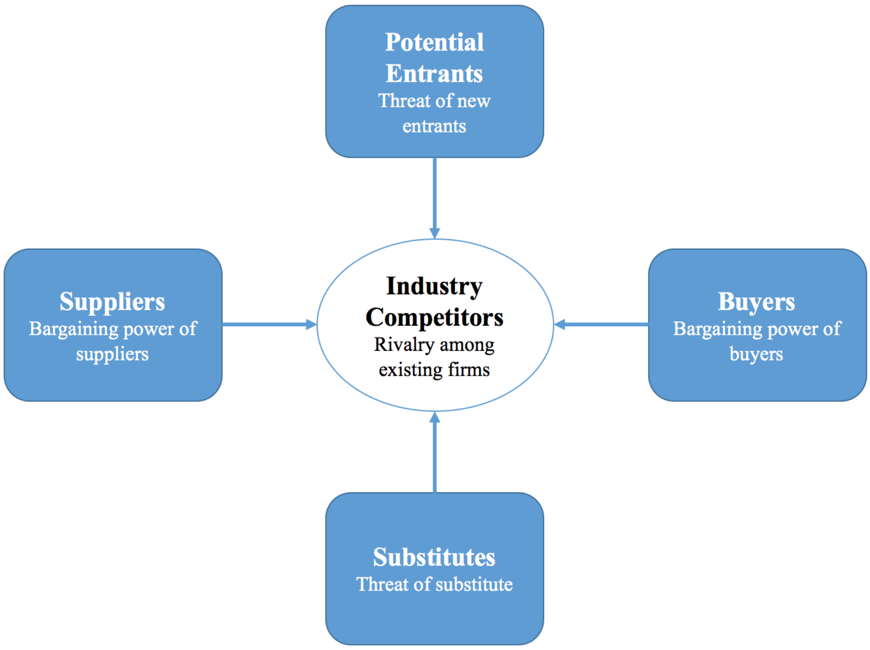

Figure 9. Five forces which drive industry competition (Porter, 1980).

Threats of new entrants refers to new capabilities which are brought to the market. These often push down pricing power of old capabilities. Thereby, profitability will be reduced (Porter, 1980). The threat of new entry depends on the barriers to enter the market and on reactions from existing actors on the market.

Bargaining power of buyers refers to buyers' capacity to force down prices and at the same time bargaining for higher quality (Porter, 1980). That can be done in several ways. For instance, having competitors to play against each other, purchasing of large volumes in relation to sales of suppliers and to use standardised products.

Threat of substitutes is the degree of competition from another industry that delivers products or services which can be used as substitutes to replace current offerings (Porter, 1980). A substitute may hinder a firm to increase its pricing or altering a product. Substitutes often comes rapidly when development drives competition. This as development causes price reductions or improvement of product performance.

Bargaining power of suppliers is the suppliers' possibility to raise prices or to reduce the quality of the product/services while pricing levels remain stable (Porter, 1980). Suppliers can either be powerful by acting on their own or as a group. Suppliers possess higher bargaining power if their products are differentiated. That as differentiated products lead to higher switching costs for buyers.

Rivalry among existing firms indicates strategies existing actors on the market use to create strong market positions (Porter, 1980). One example is when one player changes its price or product and competitors respond by counter moves. The responsiveness makes the firms mutually dependent. If the level of responsiveness is too high, it can have negative impact on the market and its companies.

3.5.6.2 Platform control

Porter's five forces was created in the 1980 before the digitalized economy emerged. The model is still used. However, since one of the selected cases of this study uses a platform as a business model the authors decided to complement porter's five forces by including theory of how different elements of platforms can be used to achieve market control. To create market control for platforms, factors such as level of openness, value creation processes, M&As, and data management have to be managed (Parker et al., 2016).

Level of openness - It is a challenge to decide a platform's level of openness to make it successful (Parker et al., 2016). The level of openness regulates how the platform can be used, monetized and how participants or developers should be governed. On the one hand, an open platform may encourage innovation. On the other hand, an open platform could make it harder for the founder(s) to control IP and to monetize from the platform.

To regulate a platform's level of openness, a manager can use different means (Parker et al., 2016). To create exclusive access to essential assets, platform managers develop rules, protocols, and barriers to reduce multihoming of users (Parker et al., 2016). Multihoming means that actors interact on several platforms to achieve similar purposes. Besides direct rules, a manager can incur charges for specific use of the platform. That indirectly makes undesired use unattractive. A platform manager has to regulate the level of openness for all stakeholders on the platform. The stakeholders can usually be categorized into users, developers, sponsors and managers. The roles and responsibilities of the different stakeholders vary between platforms (Parker et al., 2016). For some platforms, the manager of the platform is responsible for the operation and the structure of the platform while another actor is the sponsor of the platform's technology. A platform sponsor keeps the legal control of the platform's technology.

One actor can both be the sponsor and the manager of a platform. In such case, one single entity has the overall control of the platform (Parker et al., 2016). However, when the sponsor and manager of a platform are two separate entities, the situation is different. Then the manager controls and organize interactions on the platform between customers and producers. The sponsor, on the other hand, controls the platform's architecture and intellectual property. In such scenario, the manager is positioned closest to the actors located on the platform. Thereby, the manager has major influence on the daily operations of the platform. The sponsor, on the other hand, usually has more economic and legal control of the platform. That means that the sponsor tends to have more long-term control and impact on the platform.

The level of a platform's openness has impact on the quality of the content added to the platform (Parker et al., 2016). To achieve high quality of content and to control what is added to the platform, managers of platforms can employ different types of curation. Furthermore, by using screening and feedback processes, the manager of the platform can decide which actors, developers and activities that are allowed on the platform.

Value creation processes - To offer new interactions and additional value on platforms, platform managers can attract external developers by giving them access to the infrastructure of their platforms. Different types of developers can be attracted depending on what value a platform manager wants to add to the platform. Developers can be categorized into core developers, extension developers and data aggregators (Parker et al., 2016).

- *Core developers* create functions which facilitate value creating interactions on platforms.
- *Extension developers* offer additional value creation on platforms, e.g. applications. To facilitate a high degree of openness towards extension developers, some platforms provide application programming interfaces (APIs). An API consists of standardized tools to build software, protocols and routines.
- *Data aggregators* are external developers which improve matching of interactions. Data aggregators use multiple sources of platform information and sell the information for e.g. advertising purposes. Data aggregators usually get platform access through licensing agreements with the manager of the platform.

With different developers connected to the platform, the manager of the platform has to decide which parts that should be controlled and by whom (Parker et al., 2016).

Mergers and acquisitions - One of the main purposes of M&As in platform business, is to acquire a base of users that overlaps the own platform's user base (Parker et al., 2016). In addition, acquisitions can also be relevant if features on other platforms are so attractive that they may attract users from the own platform. To avoid that, managers of platforms either have to provide similar features on their own platforms or via partners. If a feature is provided by a partner, a platform manager can gain envelopment effects. Envelopment effects means that one platform gains new users from other platforms.

Data management - To create a successful platform, management of data is important (Parker et al., 2016). Data as a competitive force can be used tactically and strategically. Tactically means that data is used for testing. For instance, to find the best position or attributes of a feature. Strategic use of data implies that data is used for analysing the platform's users' activities inside and outside the platform's ecosystem. By using data analytics, a platform manager can gain deeper understanding of its users and their activities. Hence, a platform manager has the possibility to use the insights to offer and facilitate more efficient value creation on the platform. By controlling strategic data of a platform, it is difficult for competitors to offer similar interactions. That means that platforms can use data to create what Porter calls a barrier to enter the market.

3.6 Theoretical framework

The theory used in this study has been synthesized into one theoretical framework. To identify IoT generated values, IoT theory, IoT enabled business models, the IoT value model has been included in this study's theoretical framework. The technology tree has been included in the theoretical framework in order to disaggregate IoT values into technology components. This makes it possible to approach the components from an IPR perspective. Thereby it is possible to examine how different building blocks can be used to leverage the value on the market. The building blocks of this theoretical framework are: rights-based control (patents, copyrights, trademark protection and design rights), trade secrets, contractual control, technical control, and market control.

4. Case studies

The following chapter contains the empirical results of the two cases studied in this study. The chapter includes the following sections for each case; introduction, value proposition, technology breakdown, IoT value model, intellectual assets and IPRs.

4.1 The Tork® EasyCube®

The following section presents the case study of the Tork EasyCube. The section starts by giving an introduction to the Tork EasyCube. The section then continues by describing The Tork EasyCube's value propositions, its technology breakdown and its generated values.

4.1.1 Background information

Essity was founded in year 1929 as a forest company called SCA. Over time, the company evolved from being a pure forest company to become a company that also offered personal care and tissue products (SCA, 2018). In year 2017, SCA was divided into two companies. The forest product company SCA and the hygiene- and health company Essity. In the time being, Essity is one of the largest hygiene- and health companies in the world. One of Essity's largest brands is Tork. Tork includes two main product lines; dispensers and refills (Essity, 2018a). During recent years, in relation to Tork, Essity has introduced a new product on the market, the Tork EasyCube. The Tork EasyCube is a web-based service that offers data driven cleaning processes to its customers, see *Figure 10*. The Tork EasyCube collects and analyses data from dispensers and devices. Thereby it can suggest when a customer's area is to be cleaned or when a dispenser needs refill. The Tork EasyCube increases work efficiency and reduce customer complaints. Customers interact with the Tork EasyCube through a web-based application.

Figure 10. An illustration of the Tork EasyCube and its three main modules; (1) the sensor technology that measures the number of visitors, levels of refill and the transmits data, (2) the data is collected and aggregated on Essity's servers and (3) that customer access the data through the Tork EasyCube web application.

4.1.2 Value proposition

The main value proposition of the Tork EasyCube is *smarter facility cleaning* with digital intelligence (Essity, 2018b). The digital intelligence enables a *new level of efficiency and effectivenes*s of cleaning operations. In addition, the user web-application enables users to work together with the Tork EasyCube. The increased efficiency and effectiveness achieved by the Tork EasyCube, have *positive impact on manpower* and *reduce cost*. Through the Tork EasyCube's analytics, customers receive data of when, where and what dispensers that need to be refilled as well as the number of visitors per hour for designated areas. The analytics brings the following benefits; *higher customer satisfaction, increased staff engagement* and *real-time data*.

The batteries needed for the sensors of Tork EasyCube have a lifetime of five years. The sensors of the Tork EasyCube communicate with local gateways installed at customers' sites. The communication between sensors and local gateways is carried out by a proprietary protocol of Essity. The gateway then relays the information to Essity's server via GSM/GPRS (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018). The route of communication, from local sensors to Essity's server, does not need involvement of customers' IT-divisions. Keeping the Tork EasyCube and customers' IT-systems apart, reduces the risk of *system breakdowns and complicated integration processes* and *the data can be kept safely stored*.

4.1.3 Technology tree

The Tork EasyCube consists of a multi-layer technology infrastructure. The main components of the Tork EasyCube are the device, gateway, server and user interface (Essity, 2018c). *Figure 11* illustrates the overall hierarchy of the Tork EasyCube's technology.

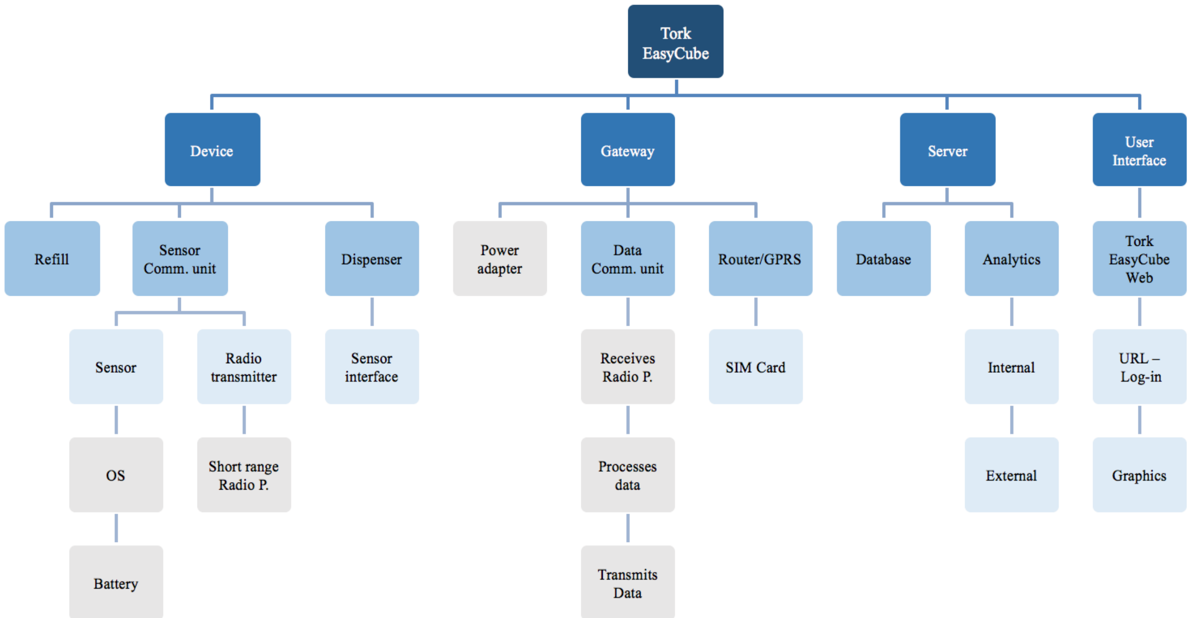

Figure 11. Technology breakdown of the Tork EasyCube.

The *dispenser* comprises of a container, refill material and a sensor communication unit. The sensor communication unit's components are the sensor, the software that defines the functions of the sensor and the battery. The radio protocol used for communicating sensor data from the dispenser to the local gateway has been developed in-house and is proprietary of Essity. The local *gateway*, through the data communication unit, receives data from sensors, processes sensor data and transmits data to Essity's server at specific intervals. The gateway consists of a power adapter, a data communication unit and a router. The *server* includes a database and programs for analytics. The analytic programs provide two types of analysis, (1) analysis for Essity and (2) analysis for customers. Analysis provided to customers are delivered via the web-application (the user interface). The *user interface* includes the Tork EasyCube Web that is accessible via an URL-login. The URL-login can be accessed from any device with internet connection. For instance, a tablet, phone or a computer. There are two different types of user interfaces, one for facility managers and one for cleaning staff. Each interface displays graphics to match each user group's needs and requirements (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018).

4.1.4 IoT value model

The theoretical foundation of this study describes that new types of values are generated by the IoT. The majority of these values will be be created by multiple actors in an ecosystem (Turber et al., 2014). Such an ecosystem will be structured differently depending on the characteristics of the IoT solution.

The following section is the result of applying the IoT value model framework to the Tork EasyCube. The section visualizes and explains the different values created in each IoT layer of the Tork EasyCube. Based on the technology breakdown of the Tork EasyCube, nine different value layers were identified, see *Figure 12*. Due to confidential information, suppliers have only been categorized into software suppliers and suppliers of physical goods.

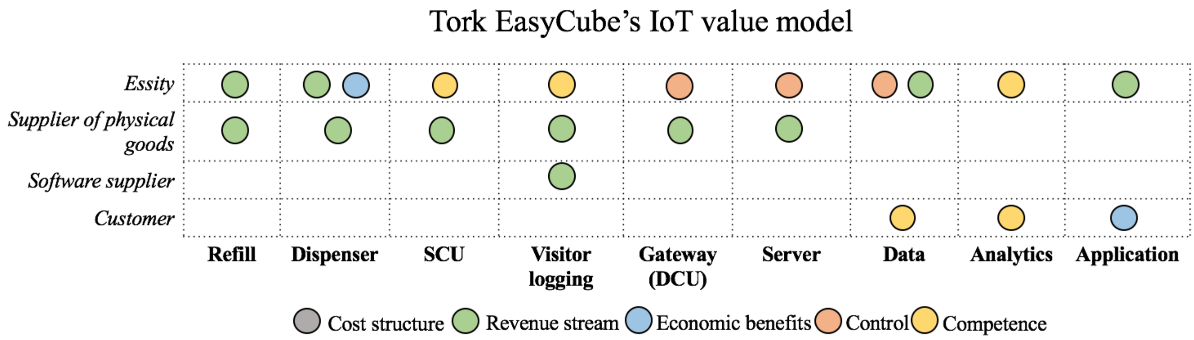

Figure 12. 2D visualization of the Tork EasyCube's IoT value model.

Refill - The first value layer is the refill layer. Refills are offered by Essity to customers. Customers pay-as-they-use. Thereby Essity and Essity's suppliers receive monetary value from a revenue model (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018).

Dispenser - Dispensers generate monetary values for both Essity and its suppliers when dispensers are sold. In addition, the dispensers bring economic benefits to Essity as buyers of dispensers are likely to buy refills from Essity as well.

SCU and visitor logging - The third and fourth value generating layers are the SCU-layer and the visitor logging layer. The sensors and the technology within the sensors are delivered by two types of suppliers, (1) suppliers of physical components and (2) suppliers of sensor technology and sensor software (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018). Both types of suppliers receive monetary value when their products are bought by Essity. Essity, on the other hand, obtains value defined as competence. This as sensors provide Essity with customer data that can be used to gain insights and knowledge of customer needs. That data can later be leveraged to strengthen customer offerings.

Gateway and Server - The gateway and the server do not provide customers with any direct value. However, the hardware needed for the gateway and the server are provided by a third party. That party receives monetary value when the hardware is sold to Essity. The gateway and the server are owned by Essity. Essity is the only receiver of sensor data and stores the data (Essity, 2018c). Thereby Essity gains the value of control.

Data - The data is stored and owned by Essity. Customers are offered processed data or refined data which can be used in different ways (Essity, 2018d). By owning the data, Essity gains control and when data is sold, Essity receives monetary value.

Analytics - The analytic processes are performed on data aggregated from sensors. There are two types of analytics, internal and external (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018). External analyses are provided to customers through the web application. The analytics, through the web application, provide customers with the value of competence. For Essity, the analytics gives the value of competence as analytics are the base for its web-based customer offerings.

Application - The user web-application is offered to customers as a subscription model that generates revenue streams to Essity. For customers, the application provides economic benefits since the application can be used for several effectivisation purposes (Essity, 2018b).

4.2 The Bosch IoT Cloud

In this section the case study of the Bosch IoT Cloud is presented. The section includes an introduction to the Bosch IoT Cloud, its announced value propositions, its technology breakdown and its generated values.

4.2.1 Background information

Bosch is an international engineering and electronics company founded in year 1886. Bosch offers a variety of products. During recent years, Bosch has taken a step into the connectivity market and aims to become a leading player within the IoT. To achieve that goal, strategic alliances and partnerships have been developed in order to offer the best IoT solutions on the market (Bosch Global, 2018). One of Bosch's IoT offerings is the Bosch IoT Cloud. The Bosch IoT Cloud consists of three main elements; IaaS, PaaS and SaaS, see *Figure 13* (Bosch, 2017). Bosch both controls the cloud infrastructure and the software layers of the Bosch IoT Cloud. Bosch offers customers to connect their devices to the Bosch IoT Cloud. Thereby customers get access to applications and services. Bosch sees itself as a leader within IoT solutions and IoT platforms. The Bosch IoT Cloud is based on open standards and open source. This to enable collaborations with external parties and to attract external services and functions to the platform. According to the Experton Group AG (2016), the Bosch IoT

Cloud has the strongest market position and highest competitive strength in Germany[1] compared to other actors such as Microsoft, Amazon and IBM.

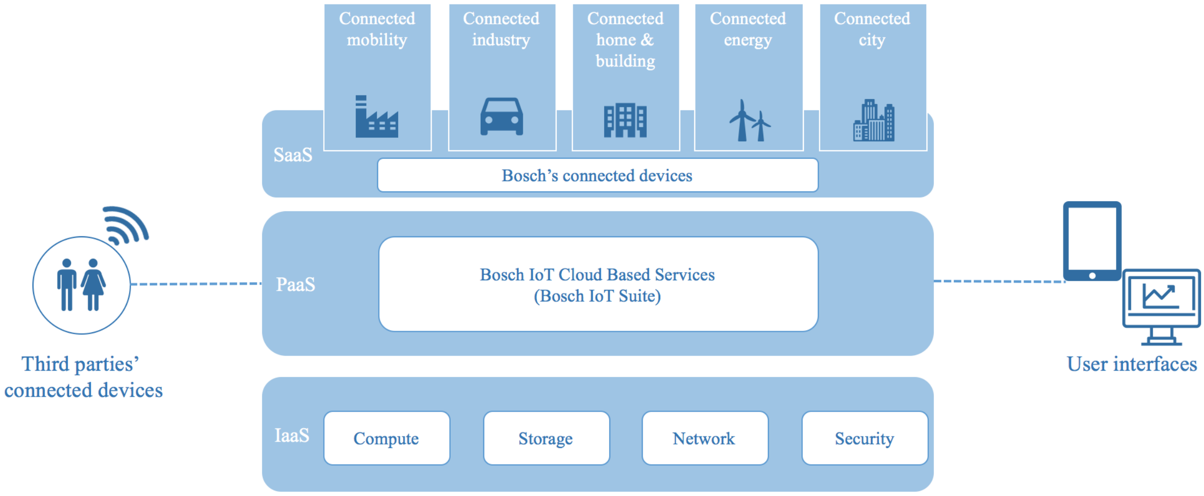

Figure 13. Visualization of the Bosch IoT Cloud and its core components.

4.2.2 Value proposition

The main value proposition of the Bosch IoT Cloud is that it includes the infrastructure, middleware capabilities, and applications needed to build a complete IoT ecosystem. The Bosch IoT Cloud is communicated to be trusted and secure and it comprises the *highest privacy standards* and *modern security mechanisms* (Bosch, 2018). The Bosch IoT Cloud offers software development and agile methods to help customers to *deploy their services within minutes*. By using services of the Bosch IoT Cloud, customers can focus on developing IoT applications, while Bosch promises to take care of the *development, hosting, storage, and maintenance* of the platform. Thereby customers will *reduce related costs* of developing IoT solutions. The Bosch IoT Suite is a platform based on *open source* and *open standards*. The Bosch IoT Suite provides *seamless integration* with other platforms and services (Bosch, 2018b). Bosch offers seven cloud based add-on services on the Bosch IoT Suite. These services are as follows (Bosch, 2017):

- *Bosch IoT Analytics* - Analytics to process and manage vast amounts of data. The main features of the analytics services are pre-processing of data, analysis of data, and data visualization (Bosch, 2018d). Pre-processing of data implies that data is refined and aligned to features and parameters which are domain specific. The analysis of data is carried out by data-mining algorithms with purpose of e.g. detecting anomalies. Finally, data visualisations provide visual solutions for presenting results of analysis.
- *Bosch IoT Hub* - The Hub is a service that facilitates connectivity of device data protocols and IoT applications. The hub makes it possible to forward device telematic data based on different protocols to applications. According to Bosch (2018d), the Bosch IoT Hub provides

[1] Germany is the strongest economy in Europe and the fourth strongest economy in the world (Bada, 2018).

reliable, secure and scalable solutions for connecting IoT devices to applications by the use of a uniform API.

- *Bosch IoT Gateway Software* - The software is based on open standards and open APIs. According to Bosch (2018d), the gateway software supports most communication protocols in order to integrate and distribute device data to applications. When a device has been connected and integrated to an application, the device is compatible with all existing and future applications.
- *Bosch IoT Permissions* - The service provides management, authorization and authentication of users (Bosch, 2018d). The service allows customers and operators to manage and allocate rights and permissions for their groups of users. The service is based on different hierarchies of user rights and contribute to reduce the risk of errors when administering users. Thereby, the costs of administering users are reduced.
- *Bosch IoT Remote manager* - A back-end system for monitoring and managing devices and gateways (Bosch, 2018d). The remote manager is based on technology of ProSyst. The remote manager is compliant with the majority of industry standards for remote device management. The remote manager enables users to manage firmware and software updates of devices. In addition, the service offers monitoring and diagnostics of device statuses.
- *Bosch IoT Rollouts* - A service that enables software rollouts to devices (Bosch, 2018d). The service facilitates large scale updating processes as well as updates of individual devices.
- *Bosch IoT Things* - An integration service that integrates IoT devices with applications, cloud-based services or other devices (Bosch, 2018d). The IoT Things enables data from devices, applications and other services of the Bosch IoT Cloud to be redistributed and used within various IoT solutions.

4.2.3 Technology tree

The Bosch IoT Cloud is based on several technology layers. The main components of the Bosch IoT Cloud are the device, gateways, server/cloud and the user interface. A detailed technology breakdown of the Bosch IoT Cloud can be seen in *Figure 14*.

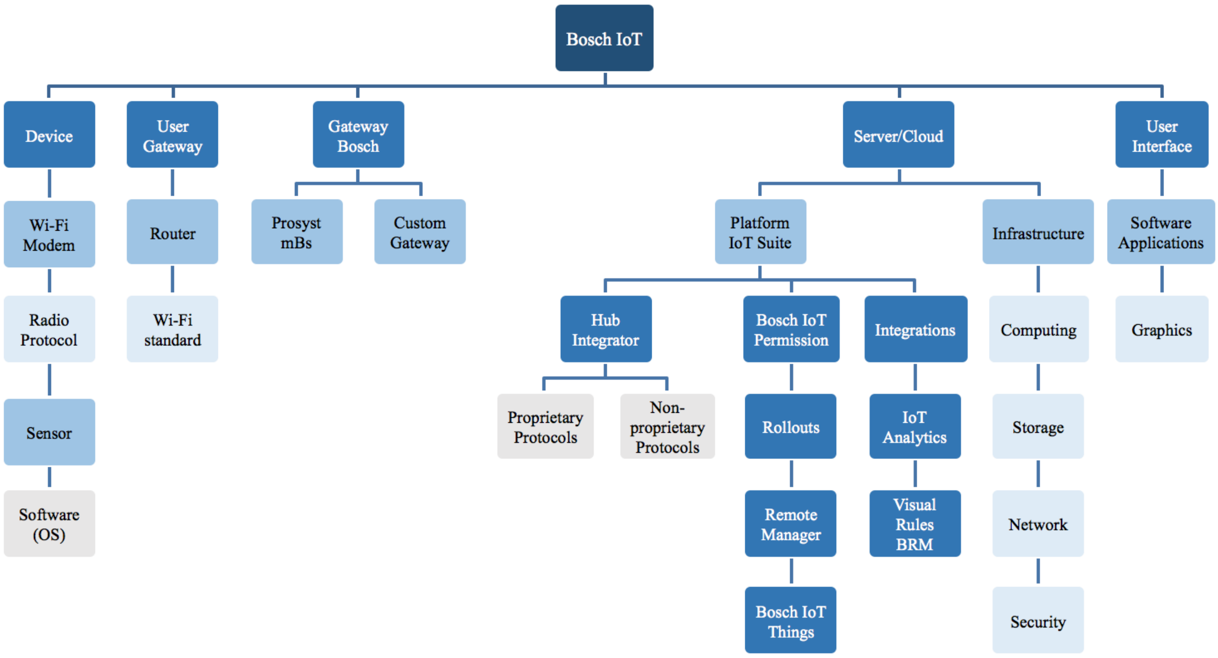

Figure 14. Technology breakdown of the Bosch IoT Cloud.

The device can either be developed in-house or by third parties. The device comprises of a sensor that measures pre-specified levels. The sensor data is then processed and transmitted via a radio protocol (Wi-Fi) to a local router. The router forwards the device data to Bosch's internal gateway. The gateway receives the data (different communication protocols) and transforms it to a uniform protocol. The standardized data is then integrated and redistributed to applications or services of the Bosch IoT Cloud. The Bosch gateway is based on OSGi standards and has been developed by Prosyst (Bosch, 2015).

The Bosch IoT Cloud is based on two main parts, the cloud infrastructure and the platform (the Bosch IoT Suite). The infrastructure comprises of four key elements, (1) computing, (2) storage, (3) network and (4) security (Bosch, 2017). The platform consists of the following components (Bosch, 2018):

- IoT Analytics - Analytics that processes and analyses data. These processes include machine-learning and data mining.
- IoT Remote Manager - Facilitates management of IoT devices. The IoT remote manager is based on OSGi standards and open APIs.
- IoT Integrations - Enable integration of devices and applications.
- IoT Permissions - Facilitate management of user groups.
- IoT Rollouts - Enable software and firmware updates of both specific and multiple IoT devices.
- IoT Things - Integrate IoT devices and allows for information sharing between devices.
- IoT Visual Rules BRM - Rules and modelling of business processes.
- IoT Hub - Integrates different data protocols with an API that forwards the data to applications.

- User Interface - The application that delivers the end-user value.

4.2.4 IoT value model

Bosch has announced that the company believes in openness. During recent years, Bosch has established several strategic partnerships to increase the value of Bosch's IoT based offerings (Denner, 2017). The technology breakdown of the Bosch IoT Cloud identified five main IoT layers. These five layers have been further broken down into twelve value generating components, see *Figure 15*.

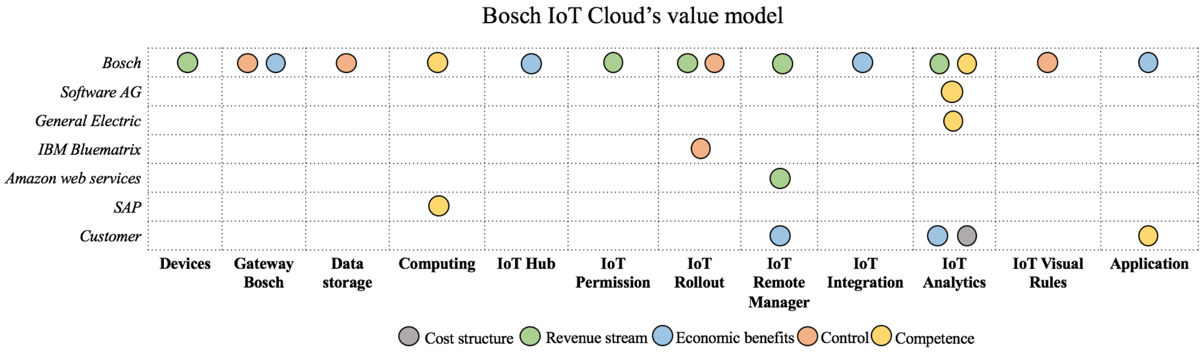

Figure 15. 2D visualization of the Bosch IoT Cloud's value generating components.

Devices - Devices embedded with sensors which are sold to customers. Thereby devices create revenue streams to Bosch.

Gateway Bosch - The values generated by Bosch's gateway is both control and economic benefits. Bosch gains control as the manager of the gateway and economic benefits as the gateway is an important component of several services which generate revenue streams to Bosch (Bosch, 2018a).

Data storage - The data generated from the devices is stored on Bosch's servers. That provides Bosch with the value of control. By controlling the data, Bosch can leverage the data in several ways (Denner, 2017).

Computing - Parts of the computing processes are carried out by SAP's HanaDB (Denner, 2017). The collaboration between Bosch and SAP provides both partners with information and insights. Thereby, both partners gain the value of competence.

IoT Hub - The hub is the messaging backbone of communication between different protocol connectors (Bosch, 2017). The Hub integrates data from non-proprietary and proprietary protocols with applications through an API. The IoT Hub is offered to customers for free (Bosch Software Innovations, 2018). The Hub provides Bosch with economic benefits as it contributes to increase the attractiveness of the Bosch IoT Cloud. Thereby Bosch can gain additional revenue streams.

IoT Permissions - A service for managing users. The service enables control of role-based access for different applications (Bosch, 2017). Bosch offers the IoT Permissions both as a freemium and premium model to customers where they pay based on their usage (Bosch Software Innovations, 2018).

IoT Rollout - A program that manages large-scale rollouts of software updates (Bosch, 2017). Bosch offers the IoT Rollout both as a freemium and premium model to customers where they pay based on usage. Through a collaboration with IBM, the IoT Rollout service is available on the IBM Watson and IBM Bluemix platforms (Smigala & Haushalter, 2017). The IoT Rollout enables Bosch and IBM to control the security, privacy and flexibility of software updates of IoT devices. Thereby both actors gain the value of control.

IoT Remote Manager - The remote manager is developed by Bosch and enables administration and monitoring of devices (Bosch, 2017). Bosch offers the IoT Remote Manager both as a freemium and premium model to customers where they pay based on usage (Bosch Software Innovations 2018). In year 2017, Bosch announced a partnership with Amazon Web Services (AWS). That partnership implies that Bosch's IoT remote manager is offered on the platform of AWS. The partnership enables Bosch to grow its IoT Suite platform faster. In exchange, Amazon gain commissions when the IoT Remote Manager is sold on the AWS platform (Denner, 2017). Thereby both actors gain the value of revenue streams.

IoT Integration - The Bosch IoT Suite uses the Eclipse Hono (based on open source) for integrating device data with services located on the IoT Suite platform. By using the Eclipse Hono, it is possible to connect different devices regardless of what communication protocol they use for communicating data. The Eclipse Hono is based on Java and is an open source project (Bosanac, 2018). Bosch has contributed with more than 60% of the project (Eclipse, 2018). By facilitating easier integration of devices through the Bosch IoT Suite services, the attractiveness of the Bosch IoT Suite grows. Thereby, Bosch can gain future economic benefits.

IoT Analytics - Services which are easy to use and applicable to IoT generated data (Holmquist-Sutherland, 2017). The IoT Analytics service offers insights of connected devices. Customers obtain either the value of cost structure or economic benefits. This as the insights provided can both be used to reduce costs and/or to find new efficient working processes. Bosch offers the IoT Analytics service as a subscription model. The software used for the IoT Analytics service has been developed in a collaboration between Bosch and Software AG. The analytics functions are based on General Electric's software. In return, General Electric receives Bosch's production performance manager (Denner, 2017). Through the partnerships, Bosch, Software AG, and General Electric gain insights of IoT devices connected to the Bosch IoT Cloud. Thereby, Bosch, Software AG and General Electric increase their in-house competence.

IoT Visual Rules - Rules and models created by Bosch to efficiently merge IT and business (Bosch, 2018c). According to Bosch, flexible business rules are key to success in today's continuously changing markets (Bosch, 2018c). Bosch gains the value of control as the IoT Visual rules are part of the development process of the IoT Suite platform. In addition, Bosch obtains increased control as the IoT Visual Rules define some of the IoT Suite's boundaries.

User Application - Bosch offers several IoT user applications. One example is the Bosch Home Connect. The Bosch Home Connect is a web-application that enables users to remotely control and monitor their IoT devices via a smart tablet (Deboer, 2017). In addition, the Bosch Home Connect provides the user with data of device performance. Thereby, users gain the value of competence. The user application is free to download on App Store and Google Play. The more users of the application, the more data Bosch can collect in order to improve its value propositions. Thereby, Bosch gains the value of economic benefits.

4.3 Intellectual assets and IPRs of the Tork EasyCube and the Bosch IoT Cloud

The intellectual assets and IPRs of the Tork EasyCube and the Bosch IoT Cloud are presented in the following section.

4.3.1 Intellectual assets

Intellectual assets are created when knowledge, know-how or learning are documented (Sullivan, 1999). Once intellectual assets have been documented, a firm can apply different control mechanisms to control its intellectual assets (Petrusson, 2016). To assess which control mechanism that should be applied to each of the Tork EasyCube's and the Bosch IoT Cloud's intellectual assets, the assets first have to be identified.

Due to the confidential nature of corporate information, it is difficult to accurately tag and map all intellectual assets of the Tork EasyCube and the Bosch IoT Cloud. However, by applying the theory presented in section *3.4.1 Intellectual assets,* the intellectual assets of the Tork EasyCube and the Bosch IoT Cloud have been identified from an external perspective. The identified intellectual assets can be found in Appendix A1 and A2. The process of categorization, tagging and mapping intellectual assets was based on the following criteria: (1) components provided by third parties are not regarded as intellectual assets and (2) use of public information only, and (3) if the authors have identified several intellectual assets of a component, the authors have not prioritized them due to lack of market knowledge.

The identification process of intellectual assets, resulted in seven main categories of intellectual assets for the Tork EasyCube and the Bosch IoT Cloud. These categories are (1) technical solutions, (2) software, (3) databases, (4) data, (5) instructions, (6) visualizations and (7) observations. *Figure 16* indicates in which operational IoT layer each of the intellectual assets are located within and what value they generate.

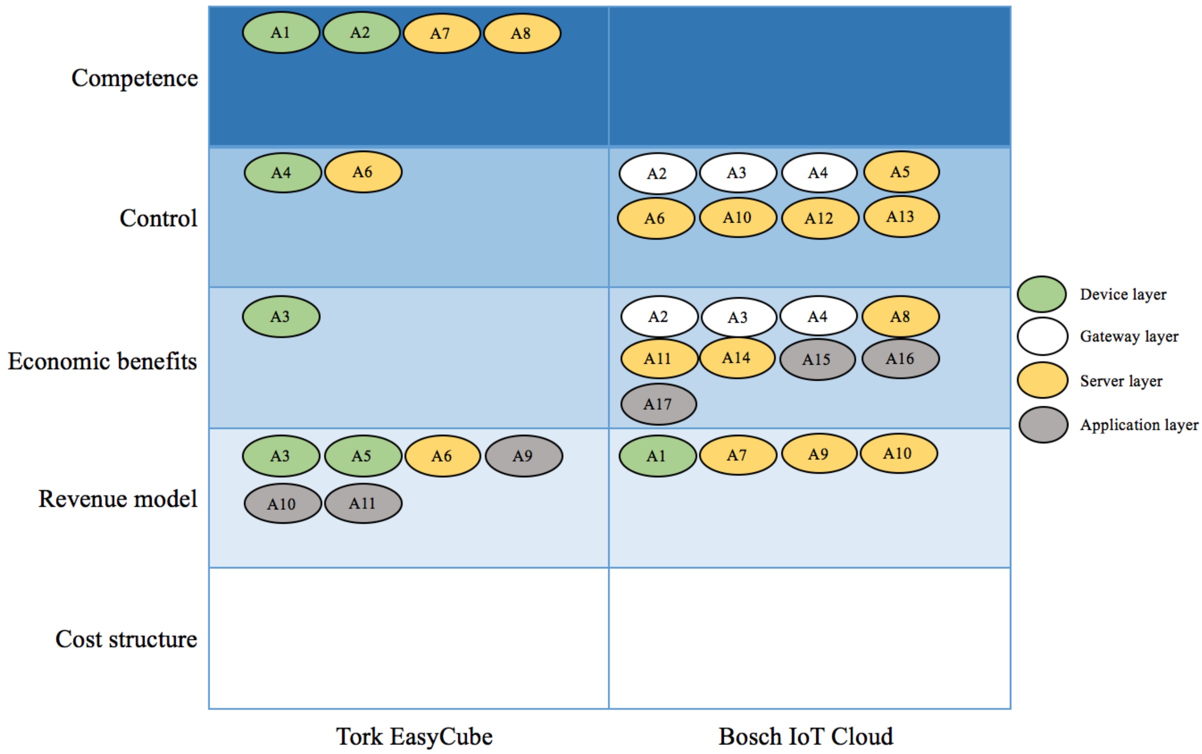

Figure 16. Visualization of potential intellectual assets of the Tork EasyCube and the Bosch IoT Cloud.

4.3.2 Bosch's patent, trademark and design rights activities

To control and protect IoT technologies McLean, Angers, & Grbic (2017) have identified four main technology areas which can be controlled through patents. These are *things*, *gateway and network*, *compute and storage,* and *analytics*. These categories have been used to assess the number of granted and pending patents within Bosch's IoT patent portfolio. In year 2017, Bosch had 1500 patents in the area of things, 177 patents for gateway and network, 1060 for compute and storage and 528 for analytics (McLean et al., 2017).

By searching the European Intellectual Property Office's database, the authors can also conclude that Bosch uses trademark protection for the Bosch IoT Cloud. In addition, Bosch has registered design rights for screen displays, user interfaces and graphical user interfaces. Further, Bosh also has registered design rights for physical products.

4.3.3 Essity's patent, trademark and design rights activities

Essity uses several rights-based control mechanisms to protect the Tork EasyCube. By using the patent intelligence tool CIPHER, the authors found that Essity (through registrations by SCA Hygiene Products AB), has twenty entries within CIPHER's technology domain of data collection, user interface and monitoring system. These entries are either granted patents, pending patents or inactive patents. These indicate that Essity files for patents which can be used for IoT solutions. Based on McLean et al's (2017) IoT categories, described in the previous section, the authors found that Essity partly or completely files within all four categories of things, gateway and network, compute and storage, and analytics.

The authors also found that Essity (Essity Hygiene and Health Aktiebolag) has registered trademarks which can be tied to the Tork EasyCube. Essity has registered word marks for *Tork* and *EasyCube* and registered figurative marks (label, paper and packaging material) in relation to Tork. For design rights, Essity has registered design rights for different parts of dispensers and ornamental effects, e.g. characteristics of paper. The case study of Essity, indicates that Essity uses its trademarks and design rights to control and leverage the value of the Tork EasyCube on the market. For instance, the trademarks of Tork are applied to several of Essity's hygiene products. The Tork trademark has been used for decades and is heavily associated with professional hygiene and high quality (Tork, 2018).

5. Analysis

The following chapter presents the analysis of the empirical results gathered from the selected cases. The chapter starts by analysing the Tork EasyCube and the Bosch IoT Cloud as separate cases. The chapter then continues by analysing the two cases from a cross-case perspective.

5.1 Individual case analysis

The following section analyses each case's generated values and assessed control positions. Each case has been analysed based on the following criteria; value creation, market control, contractual control, technical control, and rights-based control.

5.1.1 The Tork EasyCube

5.1.1.1 Value creation

Lindic & Marques (2011) state that the value proposition is the value a firm delivers to its customers in order to satisfy the customers' needs. The Tork EasyCube is offered as a product-as-a-service and its value proposition is data centric. That means that the Tork EasyCube uses data to improve cleaning processes and to increase customer satisfaction. Internally to Essity, the Tork EasyCube provides four main benefits. These are (1) new customer offerings, (2) increased sales, (3) deeper customer relationships and (4) increasing profitability and cash flow (Northstream, 2017). In addition, by collecting data via the Tork EasyCube, Essity has the potential to create tailored customer offerings. With tailored offerings, Essity can differentiate itself on the market and create competitive advantages towards competitors (Feldman et al., 2016). Further, Essity can tactically use the data collected through the Tork EasyCube to create the best solutions for customers (Parker et al., 2016).

Bughin et al., (2018) have identified that digitalisation on average provides more value to customers than to suppliers. That as digitalisation on the supply side often leads to increased competition and price cuts. For a firm to reduce the risk of gaining less value on a digitalised market, a firm can become a complete-service provider (Aharon et al., 2015). Essity seems to have taken a first step to become a complete-service provider that controls the entire value chain. To continue to generate high level of value as a provider of complete-services, it is essential that a firm understands how the technology and industry evolve (Aharon et al., 2015).

Depending on in which phase of the IoT a market is within, the value drivers will be different (Aharon et al., 2015). Essity through the Tork EasyCube, can be assessed to be within the second phase of implementing the IoT. In the second phase of the IoT, software, analytics, platforms and security are seen as the main value drivers (Aharon, 2015).

Essity controls the vast majority of the Tork EasyCube's IoT layers and its generated values, the values can be seen in *Figure 12*. Several IoT layers of the Tork EasyCube do not provide monetary values. Examples of layers which generate non-monetary values are data, the server and the gateway. These IoT layers provide Essity with the values of control and competence. The values of control and competence can be leveraged against other parties in order to create collaborations needed in order to stay competitive and to create new value propositions (Brock et al., 2015).

5.1.1.2 Market control

Market control refers to market power. Market power is defined as a firm's ability to influence the price and output of a market (Foss et al., 2017). Essity achieves market control for the Tork EasyCube in several ways. One of them is by controlling the majority of the value chain. Essity has made sure to control the Tork EasyCube, from production to end product, including the installation of the Tork EasyCube at customers' sites. By not involving external parties in the installation process, Essity controls both the installation methods and processes. As a complete-service provider, Essity's market control increases. In addition, by developing deep relationships with customers and by offering them tailored solutions, Essity can gain strong lock-in mechanisms of customers (Aharon et al. 2015; Northstream, 2017; Jovanovic, 2016). Essity's strategy of connecting devices and integrating processes, creates competitive advantage. In addition, the strategy generates bargaining power towards customers. This as customers become dependent on Essity throughout the whole product life-cycle of the Tork EasyCube. Further, Essity stores and owns the IoT generated data. Thereby Essity gains control of user insights which can contribute to create competitive advantage. Parker et al., (2016) explain that a closed system like the Tork EasyCube, makes monetization easier. In addition, a closed system increases the potential of ensuring that only high-quality content is available to customers.

To stay competitive within the context of the IoT, firms will have to offer add-on services. Add-on services play important roles to increase values for customers (Feldmann et al., 2016). That is a strategy Essity has adopted for the Tork EasyCube. The Tork EasyCube enables add-on services of analytics to customers. By controlling strategic data, Essity makes it difficult for competitors to copy their offerings. Thereby, as long as competitors do not get access to the data, the data can be used to create barriers to enter the market (Parker et al., 2016). Porter (1980) explains that by being the single actor possessing differentiating resources, the firm can compete on another dimension which is key to stay competitive (Porter, 1980).

The IoT creates new competitive forces and favours first movers and superfast followers. Especially for those who have the capacity to leverage data into advantages which are difficult for other actors to match (Bughin et al., 2018). Through Essity's partnership with Microsoft, that was announced in the second part of year 2017, it is fair to assume that Essity has understood the value of data and partnerships (Essity, 2017). The partnership with Microsoft enables Essity access to the Azure, a cloud-based computing platform (Essity, 2017). According to Parker et al. (2016), partnerships can increase the market power and strengthen customer offerings (Parker, 2016). Thereby Essity's market control increases.

The market for restroom cleanliness does adopt IoT solutions. Besides Essity, Kimberly & Clark is another actor that is active on the market for restroom cleanliness. Kimberly & Clark has, as Essity, announced that the company will increase its IoT based offerings. Part of that strategy is Kimberly & Clark's partnership with IBM (IBM, 2016). The partnership includes development of intelligent cleaning and management applications for facilities that will help clients to better monitor and manage restrooms remotely. In addition, the applications will lower costs and improve customers' experiences. Further, Kimberly & Clark has announced (June 2017) that the company will team up with Georgia tech to create smart restrooms. Such restrooms will be capable of keeping track of their overall condition (Geilin, 2017). The market for restroom cleanliness changes and it is influenced by the IoT. However, whether if it will be the first or the second mover that will gain competitive advantages by offering IoT solutions, will be telled by time.

5.1.1.3 Contractual control

Essity uses contracts to control the Tork EasyCube and its related services. The dispensers used are in some cases provided for free. In such cases, the customers have to buy refill material from Essity (IP Director Professional Hygiene at Essity Hygiene and Health AB, interviewed April 13, 2018). These types of contracts create customer lock-in effects which means that data and analytics will not be provided to customers if they change supplier of refill. That way of using contracts can, as Petrusson (2016) states, contribute to deeper relationships with customers. With deeper relationships and continuous interaction between Essity and its customers, Essity's control increases.

Essity uses subscription models for the Tork EasyCube (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018). As subscription models are used, it is reasonable to assume that contracts are in place between Essity and its customers to manage terms of usage, commitments, duration and price.

5.1.1.4 Technical control

The data generated by the Tork EasyCube is stored and processed at Essity's servers. The servers and their contents are properties of Essity. Further, the development of the Tork EasyCube has been conducted in-house by Essity (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018). Therefore, it is fair to assume that Essity has a strong technical control of the Tork EasyCube. In addition, Essity has taken the decision to use a proprietary data communication protocol that sensors use to communicate with the local gateway. That means that data is transmitted and managed by Essity without involving customers' local IT systems. That increases Essity's technical control of the Tork EasyCube. In addition, to get access to the features of the Tork EasyCube, customers have to log-in to the system. This increases Essity's technical control even further.

5.1.2 The Bosch IoT Cloud

5.1.2.1 Value creation

The value a firm delivers to its customers in order to satisfy their needs is defined as the value proposition (Lindic & Marques, 2011). According to Bosch, the main value drivers of future competitive markets will not be physical products. Instead, the value drivers will be data or management of data (Bosch Global, 2018). The Bosch IoT Cloud delivers data-driven values which enable customers to build complete IoT ecosystems. The IoT ecosystem that is offered by Bosch, includes the following three elements; PaaS, SaaS and IaaS (Bosch, 2017). Each of those elements includes value-adding services in order to attract customers. To offer the highest customer value and to stay competitive, Bosch has communicated that the development of the IoT cannot be done in-house only. As a result, Bosch has entered into strategic alliances with other partners to drive the development of the IoT further (Bosch Global, 2018). An example of a partnership, is Bosch's collaboration with SAP. By using SAP's analytics, Bosch can offer its customers both collection and analysis of IoT data (Denner, 2017). Thereby, Bosch strengthens its IoT offerings of the Bosch IoT Cloud.

By offering SaaS, PaaS, and IaaS through the Bosch IoT Cloud, Bosch can collect and analyse data that can be used to generate values which go beyond cost saving (Aharon et al., 2015). As user-data is stored on Bosch's servers, Bosch gains valuable insights of its customers. By using the insights strategically, customers' demands can be captured in order to provide offers which customers have not yet thought of (Sendler, 2018). That means that Bosch can use user-data in order to differentiate the offerings of the Bosch IoT Cloud from competitors' offerings (Feldman et al., 2016). On the other hand, Bosch can also use user-data to tactically test and find the best solution for its services. Thereby, Bosch can add higher value to the services of the Bosch IoT Cloud.

Bosch, as an IoT platform provider, has the potential to establish lucrative partnerships and to realize opportunities of emerging business models (Banerjee et al., 2014). Thereby the potential of Bosch to drive its business value is increased. To further increase the value of the Bosch IoT Cloud, Bosch can foster specialised participants. Such participants receive value from data generated and captured from the IoT Suite platform (Shin & Park, 2017). The more participants connected to the platform, the more value is produced to the platform's community. Thereby, if successfully, the Bosch IoT Suite can gain network-effects. Network-effects means that the more value that is produced on the platform, the more attractive the platform becomes (Parker et al., 2016).

Compared to traditional industrial firms, the Bosch IoT Cloud enables Bosch to create new sources of value. In addition, the Bosch IoT Cloud also supplies new types of services compared to what is offered by traditional industrial-firms. New services and values are enabled by integrating IoT devices from different industries. These services are difficult for competitors to match. An example of such integration, is the interaction of the Nest thermostat with a connected oven. By connecting a Nest thermostat with an oven, an owner of a house will be notified if the thermostat notices that the oven is turned on even if the house is empty. (Nest, 2018).

Bosch's vision is to connect everything by using the Bosch IoT Cloud. To increase the attractiveness of the Bosch IoT Cloud, Bosch continuously develops new partnerships (Denner, 2017). Based on the results from analysing the IoT values generated within the Bosch IoT Cloud ecosystem (*Figure 15*), it can be concluded that both monetary and non-monetary values are generated within the Bosch IoT Cloud. The analysis also shows that Bosch strategically in-licenses features and technologies of third parties. That is done in order to create new values within the ecosystem of the Bosch IoT Cloud. Thereby Bosch strengthens its market power. To find new partnerships, Bosch has to understand why third parties would like to be part in the ecosystem of the Bosch IoT Cloud (Turber et al., 2014). By controlling intellectual assets within three out of five IoT layers, Bosch gains the values of control, competence, economic benefits and revenue model (*Figure 16*). By leveraging these values, Bosch attracts third parties which are further enticed to receive and to generate values within each of the five IoT layers of the Bosch IoT Cloud. To reach even more customers, Bosch offers some of the Bosch IoT Cloud's features on other platforms (Bosch Software Innovation, 2017). That strategy generates additional benefits for Bosch, such as increased revenues and brand awareness. (Denner, 2017).

5.1.2.2 Market control

When using a platform as a business model, firms must manage and create competitive forces based on participants, value creation processes and data management (Parker et al., 2016). According to The Economist (2017), Bosch aims to create more value by providing IoT services and data. Bosch, as a supplier of physical goods and IoT solutions, profiles itself as an actor that provides products of high quality and that manages IoT data in a trustworthy and reliable manner. Bosch will continue to provide physical products. However, by supplying software and add-on services, the company aims to offer additional value. By offering add-on services, Bosch can attract customers by continuously improving and reshaping customer offerings. Such strategy contributes to differentiate Bosch on the market. Differentiation can increase a firm's market power (Porter, 1980).

According to Bosch Software Innovations (2015), to succeed in the era of the IoT, the IoT has to be based on open source and open standards. Bosch as an actor that provides IoT solutions, offers the IoT Suite as platform as a service (PaaS). The IoT Suite provides developers with a complete cloud-based toolbox for connecting IoT devices and business users. The purpose of the toolbox, is to facilitate a faster process for developers to develop, test and deploy their IoT applications and services. The IoT Suite is the foundation of projects and solutions needed to enable rapid development and scaling of IoT applications (Bosch Software Innovations, 2016). The IoT Suite provides developers with micro services which can be reused when developing new IoT applications. In addition, developers are able to modularly deploy their Java based applications on the IoT Suite. To facilitate that, the IoT Suite is based on the OSGi open standard.

With micro services and open standards, it becomes easier to connect participants to the IoT Suite. That enables the Bosch IoT Suite, as a platform, to scale more efficiently and faster compared to traditional linear value chains. Further, that means that the Bosch IoT Suite may gain positive network-effects. This as the constant development of the IoT Suite can contribute to demand economies of scale. By gaining demand economies of scale, the attractiveness of the IoT Suite is increased and contributes to stronger market power.

By having both consumers and producers located on the Bosch IoT Cloud, the network-effects can be cross-sided. That means that consumers drive the demand of producers and vice versa (Parker et al., 2016). These network-effects may create lock-in effects of users and those are very hard for competitors to catch up on. In addition, Bosch's lock-in effects will be further strengthened as customers will have to continuously update their devices and IoT solutions based on services provided by the Bosch IoT Cloud (The Economist, 2017). Thereby, Bosch can increase the barriers to enter the market and reduce the threat of substitutes as well as increasing its bargaining power.

Besides providing a complete toolbox for developers, the Bosch IoT Suite also offers services which have been developed through collaborations or solely by third parties (Bosch Software Innovations, 2015). According to the Economist (2017), it is possible to drive innovation of platforms faster by collaborations. An example of a collaboration of Bosch, is Bosch's partnership with Parametric Technology Corporation (PTC). Together with the PTC, Bosch has launched PTC's ThinkWorx application development platform on the Bosch IoT Suite. The ThinkWorx platform allows developers to "drag-and-drop" business applications onto the platform (Bosch Software Innovations, 2015). A second example of a partnership, is Bosch's collaboration with Software AG. That partnership has resulted in an analytic tool that tracks and monitors devices.

Bosch acquires companies to strengthen its in-house capabilities and market position (Bosch, 2015). An example is Bosch's acquisition of the middleware specialist Prosyst. The acquisition was conducted to enable enhanced integration services of communication protocols on the IoT Suite and to get access to Prosyst's gateway technology. Through Prosyst, that is a member of the OSGi open standards alliance, Bosch has the potential to make an impact on how open standards develop.

Bosch has also invested in a factory for producing semiconductors, chips and in centres for developing AI (The Economist, 2017). These investments contribute to create even more customised offerings. Thereby, Bosch can increase the barriers to enter the market and reduce the risk of substitutes (Porter, 1980). Another investment of Bosch, is ETAS' (a subsidiary of Bosch) acquisition of ESCRYPT. ESCRYPT is an expert within system security (Krahl, 2012). By using the solutions of ESCRYPT, the security of the Bosch IoT Cloud is enhanced.

The IoT Suite is based on Cloud Foundry. The Cloud Foundry is an industry standard for cloud-based applications. The Cloud Foundry Foundation is a non-profit organization that promotes and develops the Cloud Foundry as the standard for cloud-based application platforms. Bosch is a member of the Cloud Foundry Foundation together with actors such as IBM, SAP and GE (Bosch Software Innovations, 2017). To speed up the development of the IoT Suite's offerings even further, Bosch has leading responsibilities within the Eclipse open source community. Bosch has become a strategic actor of the community and is a member of the Eclipse's board of directors (Bosch Software Innovations, 2015). Through the memberships of the OSGi Alliance, the Cloud Foundry Foundation and the Eclipse's board of directors, Bosch can influence how open industry standards for applications and cloud-based services develop (Parker et al., 2016).

Users subscribe to Bosch's services and are charged based on their number of connected devices, transferred volumes of data, and services used (Bosch Software Innovations, 2016). Besides on its own platform, Bosch offers its services on other platforms as well. That is possible as the IoT Suite is based on Cloud Foundry. By using the Cloud Foundry, Bosch has the possibility to choose or switch vendors for distributing its IoT Suite services. This option makes Bosch less sensitive to bargaining power from suppliers of cloud services.

Through partnerships, Bosch spreads its IoT services to other platforms where potential customers already are established (Bosch Software Innovations, 2017). Examples of such platforms are the AWS, IBM-Bluemix and Watson, and SAP's Leonardo. On these platforms, Bosch provides selected services of the IoT Suite. For instance, the partnership with AWS combines the established cloud infrastructure of AWS with Bosch's IoT services. That combination offers customers a total set of tools needed to develop cloud based applications and enterprises. As an example, the filter manufacturer Mann+Hummel has its applications located on the AWS platform and uses Bosch's device management services (Bosch Software Innovations, 2017). Further, the collaboration with IBM enables users of IBM's platforms access to Bosch's services on the IBM-Bluemix and Watson platforms. Through the collaborations, Bosch can gain envelopment effects. Envelopment effects means that Bosch can reach new users and markets through other platforms. Thereby the Bosch IoT Suite becomes larger and more powerful. However, to gain envelopment effect, it is essential that Bosch and its partners do not start competing by offering similar services (Parker et al., 2016).

A platform manager does not need to control every inimitable resource on a platform. The manager should, however, control the most valuable resources in order to control the platform on the market (Parker et al., 2016). According to Vogt (2017), the Bosch IoT Cloud is positioned as best in class in Europe for its IoT device management services. The device management services include the Bosch IoT Analytics, Remote Manager, IoT Rollouts, IoT Things, IoT Permissions, and the IoT Hub. These services are controlled by Bosch and are available on the IoT Suite platform and on the platforms of AWS, IBM and SAP.

As both an IoT platform and physical product provider, Bosch has taken a position that enables Bosch to capture the most value regardless of where that value is generated within Bosch's value chains. That type of position makes a firm a powerful player on the market (Aharon et al., 2015; Brock et al., 2013).

5.1.2.3 Contractual control

Bosch has publicly announced that Bosch favours open source and open standards and continuously looks for new collaborations and partnerships. To manage collaborations, sophisticated contractual agreements are necessary. Contracts strengthen control of value propositions, particularly when IPRs are weak (Petrusson, 2004). The Bosch IoT Cloud consists of several features which are created by different providers. These features are offered through contract-based subscription models. These contracts stipulate aspects of user commitments, limitations and duration. Through the contracts, Bosch is first obliged to safeguard functions (Haarala et al., 2010) but Bosch can also gain lock-in effects of customers.

Collaborations within IoT ecosystems and connected devices raise the concern of data ownership (Aharon et al., 2015). By using contracts, obligations and rights of an IoT ecosystem's participants can be sorted and made clear. That is crucial as features and data are jointly generated by participants within an IoT ecosystem (Stieglitz, 2002). By using contracts, Bosch regulates the ownership of data created by the Bosch IoT Cloud (Bosch Home Appliance, 2018a). The more IoT solutions which are connected to the Bosch IoT Cloud, the more data will be generated. Therefore, it is essential to keep track of who is contributing with what (Mollen & George, 2016). By using contracts which clearly define data ownership, Bosch can become more attractive and easier achieve strategic partnerships.

To fully leverage the potential of emerging IoT technologies, a firm has to create adjacent business models based on the firm's IoT technology (Aharon et al., 2015). Bosch has adopted this strategy and taken it one step further. Instead of creating business models based on Bosch's technology only, Bosch strategically works to influence open standards and open source. By having an impact on how open standards and open source develop, Bosch can influence the IoT environment. Especially in order to benefit from Bosch's open and collaborative business models based on the Bosch IoT Cloud. Both open source and open standards are licensed under different licenses. When a firm decides to use either open source or open standards, it is essential that the firm understands the licensing agreements (Millien & George, 2016). This as firms who use open sources and open standards also have obligations of contribution.

5.1.2.4 Technical control

Digital Rights Management (DRM) defines policies, techniques and tools to guide users into proper use of digital content (Subramanaya & Yi, 2006). DRM also includes encryption, security and privacy protection. The Bosch IoT Suite is considered open and its services can be accessed by third parties.

Bosch as a leading IoT provider promises to use encrypted data-protection and data-security (Bosch Software Innovations, 2017). Further, Bosch also states that the highest privacy standards and modern security are keys to succeed within the IoT. Especially since Bosch identified that its customers are concerned about how IoT data is managed and stored. To increase Bosch's credibility and trustworthiness in that matter, Bosch decided to locate its data centre in Germany. This as legislations on data storage is stricter in Germany compared to other jurisdictions (Shepherd, 2016).

To provide and ensure secure IoT solutions, a holistic IoT security approach, where all components and communication paths are secure, is needed. To enable such security solution, Bosch provides the security infrastructure needed in order to manage all IoT activities. From the Bosch IoT Cloud's back-end activities to customers' devices (Bosch Software Innovations, 2017). That means that Bosch can be seen as both the manager and the sponsor of the Bosch IoT Cloud and the Bosch IoT Suite (Parker et al., 2016). As both the manager and the sponsor of the Bosch IoT Cloud make Bosch different from its competitors. For instance, Siemens and General Electric use Amazon's services for facilitating their platforms (The Economist, 2017). By providing APIs, Bosch ensures that third parties who wants to connect to the IoT Suite platform conform to the standards of the platform. In addition, by controlling the internal gateway of the Bosch IoT Suite, Bosch controls which proprietary and non-proprietary communication protocols that are supported by the IoT Suite. As manager, Bosch has the capacity to regulate the operation and the structure of the platform. As sponsor, Bosch also controls the technology of the platform. Thereby, on the one hand, Bosch has control of the short-term/daily operations and interactions on the platform. On the other hand, Bosch also has the long-term control of the platform's technology, legal and economic aspects.

To manage technical risks and threats, Bosch uses a risk matrix where risks are assessed based on their potential impact and their likelihood to occur (Bosch Software Innovations, 2017). If risks are considered to be higher than accepted, Bosch carefully manages and takes measures to mitigate the risks. For an IoT developer in general, it is important to understand that security is never complete (Bosch Software Innovations, 2017). Therefore, security has to be continuously improved and updated. As devices connected to the Bosch IoT Suite communicate via local networks, Bosch applies user procedures for device interactions, firewalls, limited access of devices and strive for end-to-end secure connections. Bosch does that in order to compensate for poor security standards of local networks. In addition, Bosch has also created visual rules which both assist clients to improve their applications and to define the boundaries of the Bosch IoT Suite.

5.1.3 Rights-based control

To reduce the risk of unnecessary repetition, the analysis of the two case's rights-based control has been compiled into one section.

5.1.3.1 Right-based control from a component perspective

By using the technology tree, it has been possible to list and categorize the different value creating components of the Tork EasyCube and the Bosch IoT Cloud. By evaluating the components from an intellectual assets perspective, each component which are considered to be intellectual assets can be identified. By identifying intellectual assets, it is possible to manage them from an intellectual property rights perspective (Petrusson, 2016).

As been stated in section 4.3.1 the different categories of intellectual assets identified for the two cases are; solutions, visualizations, software, data, instructions, observations, and databases. These categorizes of intellectual assets can according to Petrusson (2016), be controlled and leveraged on the market by applying different rights-based mechanisms.

For intellectual assets categorised as solutions, they can be leveraged by patent protection. The concept of a patentable invention includes that an object has to have a technical effect, be of technical nature, novel, and be reproducible. Therefore, solutions, among the other categories of intellectual assets, can approached from a patent perspective.

For intellectual assets which are literary or artistic works and have a degree of independence, originality and individuality, they are automatically protected through copyright protection (Petrusson, 2016). Copyright protection also applies to computer programs. Therefore, intellectual assets categorised as software of the Tork EasyCube and the Bosch IoT Cloud can be protected through copyright protection. For instructions and observations, as intellectual assets, they are not per see covered by copyright protection. In more detail, the format that communicates the data of instructions or observations is protected through copyright. However, the data itself gathered from observations or instructions is not protected (Petrusson, 2016). Therefore, for data that is extremely valuable, an actor should try to use other control mechanisms in addition to copyright to achieve stronger protection (IP Strategist and Partner at an IP consultancy firm, interviewed the April 6, 2018). For intellectual assets categorized as databases, they can gain copyright protection. However, to be eligible to copyright protection, a database has to be the result of a significant investment or an extensive process of gathering data (Petrusson, 2016). Even though several intellectual assets of the Tork EasyCube and the Bosch IoT Cloud can be protected through copyright, other IPRs may be considered as well to further increase their IPR based protection. This as copyright protection is perceived as a relative weak IPR protection on the market (Petrusson, 2016). Firms can therefore try to improve the protection on the market by using additional IPRs. For instance, for intellectual assets within the category of visualizations or creations, these can be approached from a design rights perspective to further strengthen their IPR based protection.

To further strengthen the IPR based control position, the trademarks of the Bosch IoT Cloud and the Tork EasyCube can be protected. Thereby the marks can be protected from unauthorized use

(Petrusson, 2016). In this study, trademarks have not been identified through the technology breakdown process of the Tork EasyCube or the Bosch IoT Cloud. Instead, the authors have identified trademarks when analysing product documentation.

For intellectual assets which cannot be protected through the use of previous explained IPRs, firms can consider to use trade secrets as an alternative control mechanism (Petrusson, 2016). In comparison to IPRs, trade secrets do not ensure that one specific actor has complete control of an intellectual asset. Instead, a trade secret enables a firm to restrict actions is relation to what is considered to be the trade secret. To fulfil the requirements and to be classified as a trade secret, the trade secret has to be "*defined as information concerning business conditions or industrial relations of a person conducting business or industrial activities*" (Petrusson, 2016, pp. 344). In addition, a trade secret has to be managed in a secret way. Hence, if the information escapes from the holder, the information will cause negative effects on the holder from a competition perspective (Petrusson, 2016). Examples of intellectual assets which can qualify as trade secrets are: secret information, prototypes, drawings or undocumented specific information and insights which stay with individuals.

5.1.3.2 Rights-based control from a system perspective

As written in the previous sections, all intellectual assets except data, instructions and observations of the Tork EasyCube and the Bosch IoT Cloud can directly be protected by different IPRs. However, instead of looking at IPRs for intellectual assets individually, intellectual assets can be approached from a system perspective as well. Thereby observations and instructions may be patentable as methods depending on what technical effects they achieve within a system (European Patent Attorney and Partner at an IP consultancy firm, interviewed March 22, 2018). As an example, data may be analysed in order to find behaviours or patterns. Based on the patterns and behaviours identified, instructions within a system are carried out to achieve technical effects. For the Tork EasyCube and the Bosch IoT Cloud, such technical effects may be achieved through data transmitting/receiving processes, data cleaning, data splitting, interface connections and devices. To patent such IoT system, the starting point should be at component level. This as the components are the building blocks of the effects achieved by the system. It is, however, essential that firms evaluate whether or not methods and processes are to be patented. Furthermore, a firm should assess the likelihood of that users can figure out processes at a firm's server. If it is possible, then the processes should be considered to be patented (European Patent Attorney and Partner at an IP consultancy firm, interviewed March 22, 2018). If not, the firm should consider to keep the processes as trade secrets. The main reason for that, is that it may be hard to enforce patented processes against infringements (CEO, Open Innovation Network, workshop February 27, 2018; IP Strategist and Partner at an IP consultancy firm, interviewed on April 6, 2018). To strategically protect an IoT system, an actor should focus on patenting technologies which are seen as the most challenging for the IoT industry in general. As an example, the main feature of an IoT system may be achieved through the position of a sensor. By patenting the position of a sensor and its characteristics, an actor can control the next step of technology development. Thereby the actor can delay competitors from offering similar value propositions (IP Strategist and Partner at an IP consultancy firm, interviewed April 6, 2018).

5.2 Results

The following chapter presents the results of this study. The aim of the results is to answer the two sub-research questions of this study

5.2.1 Value creation in an IoT ecosystem

RQ1: What values are generated in an IoT ecosystem?

The values generated in an IoT ecosystem can be divided into monetary and non-monetary values. These values are usually generated by several participants of an IoT ecosystem (Vermesan et al. 2016). Monetary value is received when a product or service is sold to a customer. The non-monetary values can be divided into four categories. These categories are; cost structure, economic benefits, control, and competence (Vermesan et al., 2016).

In order to understand which values that are generated in an IoT ecosystem, the values have to be seen from a firm-, collaborative- and customer- perspective.

From a firm perspective, the emergence of the IoT and development of IoT ecosystems, enable firms to create new types of customer offerings. These offerings enable deeper customer relationships and new ways of creating cash flow (Northstream, 2017). Based on the case studies of the Tork EasyCube and the Bosch IoT Cloud, it was found that a component that generates non-monetary values within one IoT layer can be the key driver for creating economic values in other IoT layers of the ecosystem.

Data is the main driver of value creation in an IoT ecosystem. By controlling IoT data, data can be leveraged to gain real time insights of customers. That enables firms to generate differentiated customer offerings. In addition, data can be used to establish strategic partnerships (Feldmann et al., 2016). By leveraging data generated values, a firm can gain competitive advantages which are difficult for competitors to match. The IoT disrupts value chains and enables value creating ecosystems. These ecosystems allow more firms to enter "traditional industries" in order to generate and deliver values which have not been available before.

From a collaborative perspective, the two case studies of this study showed, aligned with theory, that the IoT reduces borders between industries. That enables new types of value propositions. To deliver these value propositions, collaborations will be needed in order to satisfy customers and to remain competitive. Bosch is an actor that generates new values by collaborations and leverages values from different IoT layers. By using values generated within its IoT Cloud, Bosch creates new values by offering its IoT generated values to strategic collaborations.

Through the services offered on the IoT Suite, Bosch facilitates matching of both customers and producers of IoT services. As a platform, the IoT Suite can enable Bosch to scale its IoT business faster than linear value chains (Parker et al., 2016). The more participants and devices connected to the Bosch IoT Suite, the more values are produced on the platform. By using the data generated on the platform, Bosch has the potential to capture customers' demands before customers are aware of them (Sendler, 2018).

From a customer perspective, connected devices enable deeper relationships with suppliers through continuous interactions (Northstream, 2017). That creates more loyal customers and additional values to firms as lock-in effects of customers may be gained. Customers demand smart IoT solutions which are integrated with other IoT solutions in order to deliver value. For customers, the two cases of this study showed that raw data generated in an IoT ecosystem, has little customer value. Instead, customers need to get the raw data analysed. Howsoever, analysis cannot be performed without raw data. That means that even if several actors do have the potential to deliver analysis to customers, they will not be able to do so without access to raw data. That means that the actor that controls raw IoT data, will also be able to generate new values in an IoT ecosystem.

5.2.2 Leveraging IoT value through control mechanisms

RQ2: How can a firm leverage the value on the market through different control mechanisms?

The IoT generated value can be leveraged through IPRs from a component and system perspective (European Patent Attorney and Partner at an IP consultancy firm, interviewed March 22, 2018). However, for a firm to control the value, it first must identify the IoT value drivers. By identifying value drivers, these can be managed from an intellectual assets perspective. That means that intellectual assets can be regarded as protectable or protected from an IPRs standpoint (Petrusson, 2016). By looking at the specific roles and characteristics of an IoT solutions' intellectual assets, the intellectual assets can be approached from a patent perspective. To patent an IoT solution, each of its intellectual assets must be assessed based on what technical effects they achieve. A patenting strategy for an IoT solution can be to focus on patenting components which are most challenging for the IoT industry in general. According to the European Patent Office (2017), patenting activities have during recent years dramatically increased within the IoT's technology areas. The vast majority of those patenting activities are carried out by large Information and Communications Technology (ICT) firms. These firms control a large part of the market for cloud-based services. That means that such firms have strong control positions of technologies needed in order to create cloud-based services. Further, that also means that actors which intend to use patented IoT technologies, must seek collaborations with those large ICT firms.

Additionally, patents have traditionally been one of the strongest tools to create exclusivity on markets. However, within an IoT environment, patents will most likely not provide enough protection and control on the market. Instead, for an IoT solution, a firm can build a control position that is based on several IPRs. By using different IPRs as building blocks, a firm can achieve the highest potential of rights-based control. To fully leverage the value on the market by using IPRs as building blocks, the IPR strategy for an IoT solution has to be well anchored in the overall business strategy of the firm

(CEO, Open Innovation Network, workshop February 27, 2018). That means that each IPR should be purposefully used to reach a firm's objectives.

Trade secrets can be used when IPRs are not applicable or seen as a weak protection for controlling intellectual assets on the market. Further, trade secrets can also be used when a public disclosure of an intellectual asset reduces or eliminates the potential of economic value (Petrusson, 2016). Trade secrets can either be applied to parts of, or to the entire technology. For instance, algorithms are examples of technologies where the entire technology often is recommended to be kept secret (Millien & George, 2016). However, increasing collaborations create challenges for managing trade secrets. For instance, when participants on a platform interact, they have to share technical and security details. The risks of information leakage can however be mitigated. This study showed that leakage of trade secrets can be contractually mitigated. However, even if contracts of non-disclosure agreements are in place, they may be harder to legally enforce compared to other IPRs (WIPO, 2018).

Intellectual assets such as software, applications, data, and databases are protected by copyright (Petrusson, 2016). However, copyright is seen as a relative weak protection in the context of the IoT. Therefore, in addition to copyright protection, a firm can further strengthen its IPR-based control by applying trademark and design rights. As an example, a firm can obtain design rights for user interfaces and graphics of an IoT solution to strengthen the awareness of that IoT solution. Bosch has done that for several of its IoT services. That means that regardless of where Bosch's customers are located, they will know that they use a connected product from Bosch. In an open IoT environment where collaborations are expected to increase, the importance of design rights and trademark protection is expected to grow (IP Strategist and Partner at an IP consultancy firm, interviewed April 6, 2018).

In addition to IPRs and trade secrets, other control mechanisms can be used in order to leverage IoT generated value on the market. Depending on which of the three IoT phases (see *figure 5*) an industry is located within, different drivers of value are applicable. These value drivers can be controlled and leveraged in different ways. For instance, Essity, through the Tork EasyCube, controls the value chain and leverages the IoT generated values as a product-as-a-service. By controlling the value chain, it is easier to monetize from an IoT solution compared to an open platform. However, the IoT reduces industry borders, change competitive dynamics and increase collaboration activities (Borck et al., 2013). To remain competitive as a complete-service provider, in a more open and changing environment, a firm must understand its future competitors. In many cases, competitors will emerge from different industries, therefore a provider of complete-services will most likely have to find suitable partners. That to create value propositions which are hard for competitors to copy.

Owning and controlling IoT data is an additional way to leverage IoT generated values on the market. Essity owns and controls the data collected from the Tork EasyCube. The data can be leveraged into tailor made offerings and differentiated add-on services and features. These value offerings are essential in order to gain competitiveness and can create strong lock-in mechanisms of customers (Aharon et al. 2015; Northstream, 2017; Jovanovic, 2016). Furthermore, control of data makes it difficult for competitors to create similar customer offerings. Therefore, leveraging IoT data can increase a firm's bargaining power which contributes to create higher entry barriers to a market.

The Bosch IoT Cloud, in comparison to the Tork EasyCube, leverages its IoT generated values in a different manner. Instead of a closed system, Bosch offers its IoT Cloud services as an open platform. Bosch monetizes from its services by charging customers based on data volumes and the number of devices connected to the Bosch IoT Suite platform (The Economist, 2017). To leverage the value of the Bosch IoT Suite, Bosch has strategically based the IoT Suite on open source and open standards. In addition, the Bosch IoT Suite provides external developers with a complete toolbox needed for connecting and managing IoT devices and applications (Bosch Software Innovations, 2016). This way of leveraging the value of an IoT ecosystem contributes to fast growth and development of the platform. That allows faster scaling compared to traditional linear value chains (Parker et al., 2016). In addition, an open platform may gain demand economies of scales. With demand economies of scale, a firm can gain positive network-effects. That means that the more users of the platform, the more value is produced to the community. Continuous development of platforms increases barriers for other actors to enter the same markets. As the manager of the platform, Bosch can use its market control and leverage it to create lock-in effects of users (Parker et al., 2016).

Bosch charges its users based on their number of devices connected and volumes of data transferred on the IoT Suite (The Economist, 2017). Besides monetary value, Bosch also leverages its applications and user data in exchange for technologies of third parties. By using third parties' technologies on the platform, the potential of generating more value on the platform is increased. Thereby more value is also created to the community. That contributes to make the IoT Suite more attractive.

To control the value and to create a strong market position, the case study of Bosch showed that a firm should consider to become both a sponsor and a manager of a platform. As both the manager and sponsor of a platform, a firm has control of the daily activities on the platform as well as of its technology, legal and economic aspects (Parker et al., 2016). In addition, other ways to further create and control IoT values on the market is to influence how the market(s) evolve. For instance, Bosch's memberships of the Cloud Foundry Foundation, the Eclipse Foundation and the indirect membership of the OSGi Alliance, give Bosch the possibility to take part of, and impact the overall development of the IoT.

As the IoT evolves and create new business opportunities, collaborations will increase. Further, an IoT provider can benefit from other firms' platforms. Essity has announced its partnership with Microsoft and will use Microsoft's Azure platform. Bosch on the other hand with its IoT device management services which are considered to be best in class in Europe (Vogt, 2017), leverages these services and features on other platforms. By offering services on other platforms, firms can reach new users and achieve envelopment effects. Thereby the value of the platform can be even further increased (Parker et al., 2016).

Both Bosch and Essity leverage their IoT solutions through contracts. Bosch uses contracts to remain in control of its proprietary features offered on Bosch's own and third parties platforms. Essity, on the other hand, in some cases provides the Tork EasyCube as a total solution. That means that if customers want IoT data and dispensers, they have to buy refill materials from Essity (IP Director Professional Hygiene at Essity Hygiene and Health AB, interviewed April 13, 2018). This way of using contracts can, as Petrusson (2016) states, generate deeper relationships with customers and increase the control of a product. Such contracts do also contribute to create customer lock-in effects and increase the potential of monetization (Parker et al., 2016). As Essity provides the Tork EasyCube as a subscription model (Global Innovation Manager at Essity Hygiene and Health AB, interviewed March 3, 2018), it can be assumed that contracts are in place between Essity and customers to manage customers' terms of use. Contracts strengthen the control of value propositions, particularly when IPRs are weak (Petrusson, 2004). Further contracts are important to use for controlling ownership of data (Aharon et al., 2015). The more the IoT grows, the more data will be generated and that brings the importance of keeping track of which actor that contributes with what data (Mollen & George, 2016).

6. Conclusions

The following chapter summarizes the conclusions of this study. The conclusions answer the main research question and are based on empirical data collected from literature, interviews and the two case studies.

The purpose of this study has been to provide tools in order to identify, control and leverage the value generated in an IoT ecosystem. To fulfil the purpose, the synthesized theory has been tested on two cases and the following main research question was framed:

How can the value generated in an IoT ecosystem be controlled and leveraged?

The values generated in an IoT ecosystem can be divided into monetary and non-monetary values. Monetary value is created when an IoT solution is sold to customers. The non-monetary values can be divided into four categories. These are; cost structure, economic benefits, control and competence. This study showed that non-monetary values created within one layer of an IoT ecosystem may be the key drivers of economic value within other IoT layers. One of the key assets in an IoT ecosystem is data. To control the value of data, a firm has to ensure ownership of data. That can be achieved by applying contracts, trade secrets and/or agreements. First then, the value of data can be leveraged on the market.

The value generated in an IoT ecosystem increases when the number of participants and devices grow. However, creating an IoT ecosystem only, will most likely not be enough for actors to remain competitive. Instead, IoT ecosystems have to attract specialised participants and services. This to foster more value creation. By enabling value creation processes between actors from different industries within an ecosystem, the barriers for other actors to enter the market are increased. This as such value creating processes create lock-in effects of users and are hard for competitors to match.

To control the value generated in IoT ecosystems, firms have to use different control mechanisms. One control mechanism is intellectual property rights (IPRs)s. IPRs secure rights-based control of value creators and can be used in order to exclude third parties from offering the same value. To control IoT generated values through IPRs, a firm first has to identify the components of value drivers. When the components have been identified, they can be approached from an intellectual assets perspective. Thereby, a firm can assess which intellectual assets that should be or are protected by IPRs.

To protect an IoT solution by IPRs, a firm can seek patent protection for either parts of or the entire IoT solution. The IPR strategy should be based on different IPRs. This as different IPRs can be used as building blocks to achieve the highest potential of rights-based control. Thereby a firm can strengthen its competitiveness and market power. Intellectual assets such as software, applications, data, and databases are protected by copyright. However, copyright is seen as a relative weak IPR in the context of the IoT. By complementing copyright with trademark and design rights to protect intellectual assets, a firm can obtain a stronger control position. When IPRs are seen as weak for protecting intellectual assets or when a public disclosure may reduce or eliminate the potential economic value trade secrets can be used. For instance, trade secrets can be considered for intellectual assets such as; algorithms, observations and instructions. Especially if the risk that users can figure out the processes behind the assets is considered to be low.

A firm can control and leverage values generated in an IoT ecosystem by controlling the entire value chain. By controlling the entire value chain, a firm's potential to monetize from the solution(s) and to secure ownership of IoT generated data is high. In addition, a firm that controls the entire value chain can leverage IoT data by creating differentiated add-on services and tailored offerings. That means that a firm can gain new types of revenue streams and lock-in effects of customers. However, to fully leverage the values generated in an IoT ecosystem, a firm can adopt a more open business model, for instance by providing its IoT solution as a platform. A platform enables fast scaling and the potential of demand economies of scales. This as a platform can attract both external developers and technologies of third parties. These factors increase the competitiveness of a platform and can lead to network-effects. To stay competitive, it is essential that platforms control the IoT value drivers, increase their in-house capabilities and influence markets. In order to do that, platform firms can consider acquisitions. Especially acquisitions of emerging features or services which are of higher quality compared to services offered on their own platform. This as such features may be the starting point for new competitive platforms. To enable a platform-based business model, a firm has to secure proprietorship and control of key technologies. Thereafter a firm can leverage its intellectual assets of both non-monetary and monetary values. Assets of non-monetary values can be traded in exchange for technology of third parties. On the other hand, assets of monetary value can be leveraged by selling them on third parties' platforms to gain envelopment effects. By gaining envelopment effects, a firm can get access to other platforms' users in order to offer them its monetary values.

The IoT brings challenges in relation to rights-based control of key technology areas. With less control, a firm's possibility to leverage its IoT generated values on the market is reduced. In addition, to become successful within the IoT, a firm has to find collaboration partners. However, it is challenging to find the right partners without risks of suffering from too much tension or administration. Increasing collaboration activities and openness will bring challenges of data ownership and the risk of leaking confidential information. To mitigate that risk, trade secrets and contractual agreements are recommended. Lastly, a firm has to weight the risks of a collaboration with the potential value of the collaboration.

7. Discussion

This study aims to detangle firms' challenges of how to identify, control and leverage value generated in IoT ecosystem. To do this and to enrich the research field, the study applied a qualitative research strategy where an inductive theory-building method was used. The theory-building included identification of several frameworks which were synthesized and deductively tested on two different cases. The study provided several insights that will be discussed in the following sections.

7.1 Relevance of theory

The aim of this study is to contribute to the research field by combining different frameworks into one holistic framework for IoT ecosystems. Due to the novelty of the research area, limited amount of theory has been written in relation to the research topic. Therefore, to tackle the problem, well-established theory developed before the digitization had to be complemented and synthesized with less proven IoT theory. When synthesizing and testing the theory, aspects regarding the relevance of the theory emerged.

This study takes a stand from an intellectual property perspective. Therefore, the IAM framework's building blocks have been used to examine how a firm can control and leverage IoT value on the market. In order to identify which values an IoT ecosystem generated, the IoT value model was applied. The main struggle when combining the IAM framework and the IoT value model was that both frameworks use the term *control* as an element. However, the frameworks have different definitions of the term. From an intellectual property perspective, control refers to that one actor can exclude third parties. On the other hand, the IoT value model defines control as an actor's possibility to impact or influence customers, suppliers or collaborators. Therefore, from the IoT value model perspective, commodities can be carriers of control while from an IPR perspective they are not. Hence, the frameworks can be contradictory. With this insight, to be consistent and to enable proper use of the two definitions throughout the study, the following reasoning was applied. To identify the IoT generated value, the IoT value model and its definitions were used. Then to examine how the different values of the IoT value model could be controlled and leveraged on the market, the IAM framework and its definition of control was applied. This reasoning made it possible to be consistent with results and to reduce the risk of conflicts between the frameworks. However, despite the reasoning held, this study found that the IoT value model need to be further developed and tested in order to be reliable and applicable to different contexts. Therefore, one recommendation for future research is to use the IAM definition of control and implement that into the IoT value model.

Secondly, additional insights gained when applying the IoT value model to the two cases were that more or less all the five different values of the model can be applied to all value layers. The framework stresses that in such cases, the most applicable and valuable types of values should be selected. However, the values of cost structure and economic benefits are closely related and it can be hard to distinguish them. This weakness of the framework is something that should have been highlighted by the creator of the framework. For future research, the value definitions should be reconsidered.

The testing of theory in this study contributed to the field of research as it provided a synthesized theoretical framework. That framework can be used by future researchers in order to develop the framework as well as gaining new insights from its application. To refine the theoretical framework and to make it easier to use, the authors found that the original 3D-visualization of the IoT value model had to be changed. The authors found that the original model did not communicate the IoT values in a logical manner. In more detail, the original IoT model´s value-axis (the why-axis) can easily trick the user into thinking that the highest value bar indicates the highest value, which may not be true. To mitigate this risk, the authors decided to use a 2D-visualization table for presenting the results of the model.

Despite several identified weaknesses of the IoT value model, the model showed to be a key component for illustrating IoT generated values. This study's theoretical framework delivers a tool that managers can apply in order to get a more holistic view of IoT ecosystems and what is needed to control and leverage a firm’s IoT solutions. The applicability and usefulness of this study's theoretical framework was confirmed when this study was presented at the host company. That presentation indicated that the audience was very satisfied with the holistic approach for presenting IoT generated values and how they can be leveraged.

Finally, this study can conclude Porter´s five competitive forces are applicable to platforms even though they have different value drivers and control mechanisms compared to tradition industrial firms. This as elements of platforms can be mapped into the five main categories of Porter’s model. In other words, the Porter’s five forces are still applicable to the digitized economy. Howsoever, recommendation for future research would be to examine how key forces of platforms and forces of industrial firms should be optimized to create competitiveness. Such research would be highly interesting since industrial firms are expected to connect more of their IoT solutions to platforms.

7.2 Practical implications

This study stresses that collaborations will be needed to stay competitive in the era of the IoT and that contracts should be used to solve confidential or collaborative issues. Contracts are powerful tools to use, but to blindly rely on contracts to manage transfer of intellectual assets and confidential information is not recommended. Further, to benefit from collaborations and to achieve synergies, is it crucial to find the right partner(s). In this study, data and analytics have been stated to be the key value drivers in an IoT ecosystem. However, data will not be the single source of differentiation. For example, specialization and unique knowledge are also options for differentiation in the era of the IoT. Finally, the study stresses control as the most valuable resource. However, it is essential that a firm focuses at controlling the most important intellectual assets.

7.3 Limitations of the results

Despite the in-depth conducted literature review of this study and theory application on two cases, this study has limitations. First, the literature review is not exhaustive. That means that the authors may have missed important information regarding the field of research or the theory identified. Secondly, the application of the theoretical framework on the cases was done by the authors only. That means that the authors have not gained insights of how another user would use the framework. That means that the user-friendliness of the theoretical framework cannot be established. Further, this study is based on an intellectual property management perspective. Due to the nature of confidentiality, it has not been possible to extract all case information needed in order to examine the two cases from a transparent perspective. Especially when it comes to information related to values generated by each of the cases and their intellectual assets. That means that a similar study conducted in-house, that includes all confidential case information would mostly likely result in slightly different conclusions.

7.4 Future research

It is recommended to conduct a similar study within a few years. It is also recommended to conduct a study that includes a larger number of cases. Thereby it will be possible to examine how applicable this study's theoretical framework is for other contexts. In addition, this study has examined how to leverage values within different layers of an IoT ecosystem. Instead, it would be interesting to focus on specific business areas.

Finally, since the IoT increases collaborations, it is of interest to further examine collaborations and their success factors. This study concludes that the IoT and connected devices continuously reduce industry borders and change competitive forces. Therefore, current success factors within the IoT may be less successful in the future. It is therefore suggested that a similar study is performed in the future, preferably within five to ten years, where the results of this study potentially can be compared to new insights gained.

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Appendix

A1. Potential intellectual assets related to Tork EasyCube

Table A1. Tork EasyCube: List of Intellectual Assets

List of Intellectual Assets - Tork EasyCube				
ID	*Value Layer*	*Title*	*Description*	*Category*
IA-1 IA-2	Device (SCU)	Radio protocol	A protocol is a system of rules that governs how a system operates which decided how and what information to be transmitted between two or more entities.	Data Instruction
IA-3	Device	Dispenser	A device that dispenses paper, soap etc. A dispenser can either be operated by a handle or via automatic dispensation.	Technical solution
IA-4	Device	Sensor interface	The way the sensor is integrated in the device to enable the sensors to create the needed signal conditioning to extract an accurate signal for monitoring and control systems.	Technical solution
IA-5	Device	Refill	A disposable product developed to fit the dispenser.	Technical solution
IA-6	Server	Database	A structure set of data stored on a server.	Database
IA-7 IA-8	Server	Analytics	Analytics is tools created through software codes. The analytics will enable discoveries of cause-effect relationships, correlations, trends, problems, needs, optimizations.	Software Observation
IA-9 IA-10 IA-11	Web application	User interface	The user interface is the design created by the developer of and where the customer interact with the computer and the data collected by the device.	Software Visualization Instruction (user manual)

A2. Potential intellectual assets related to Bosch IoT Cloud

Table A2. Bosch IoT Cloud: List of Intellectual Assets[2]

List of Intellectual Assets - Bosch IoT Cloud				
ID	*Key Layer*	*Title*	*Description*	*Category*
IA-1	Device			Technical solution
IA-2 IA-3 IA-4	Bosch Gateway	Router	A network node that connects two networks using different protocols. Custom gateways and Prosyst mBs (Bosch).	Instruction Technical solution Software
IA-5	Server (Infrastructure)	Storage	Structured data. Located in Stuttgart (German data protection act).	Database
IA-6	Server (Infrastructure)	Security	Security is created by software encryption to hinder unauthorized access or data to be leaked. Based on PKI (rules for securely manage digital certificates). ESCRYPT (owned by Bosch).	Software
IA-7	Server (IoT Suite)	IoT Remote manager	A backend device management, monitoring and software provisioning system for various classes. The remote manager is created by two open standards (OSGi) and Open APIs (Prosyst tech). The manager is based on Java script. Freemium and charged.	Software
IA-8	Server (IoT Suite)	IoT Integrations	An infrastructure for messaging. Eclipse Hono based on Java.	Software
IA-9	Server (IoT Suite)	IoT Permission	Authorization management and administration of users. RESTful API etc. Freemium and charged.	Software
IA-10	Server (IoT Suite)	IoT Rollouts	System for managing system software and firmware updates. Freemium and charged.	Software
IA-11	Server (IoT Suite)	IoT Things	HTTP API or Java client which facilitate integrations of cloud- or app-services as well as sharing information between devices. Freemium and charged.	Software Instruction
IA-12	Server	IoT Visual	Rules and modelling for business	Software

[2]Information in the IA list has been accessed through: https://www.bosch-iot-suite.com/analytics/

IA-13	(IoT Suite)	Rules BRM	processes. The out coming code is based on Java.	Instruction
IA-14	Server (IoT Suite)	IoT Hub	Integrates data from non-proprietary and proprietary protocols through an API to the specific APP.	Software
IA-15 IA-16 IA-17	User interface	Software application	Application software	Software Visualization Instruction (user manual)

B1. Bosch IoT Remote Manager

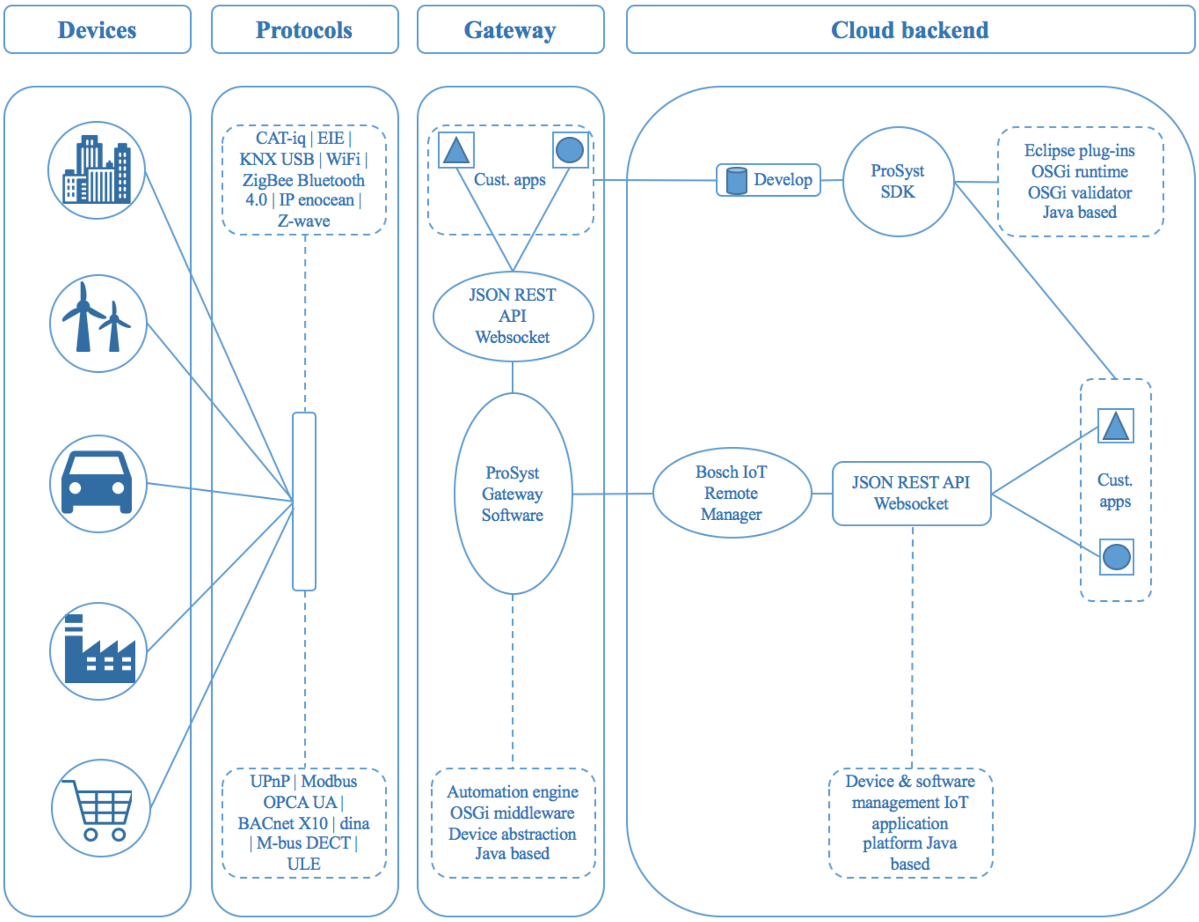

Figure A2. Bosch IoT Remote manager and its components.