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Assessment of Needed Capabilities in IoT System Development

Evaluating framework fit for the indoor climate industry

Master's thesis in Management and Economics of Innovation

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Abstract

Digitalization is changing the way companies are competing and has done so for the last few decades in three waves (Yoo, et al., 2010). The first wave was the introduction of computers and the second the arrival of the internet. The internet of things (also known as IoT) is referred to as the third wave of digitalization and is currently transforming industries. Sayar and Er (2018) present a framework for what capabilities manufacturing companies need to manage IoT systems design, by assessing two companies, one of which in the aerospace industry and one in the transportation industry. The purpose of this study is to test the framework developed by Sayar and Er (2018) for a manufacturing company in the indoor climate industry, leading up to the research question:

Is the Sayar & Er (2018) framework for capabilities for successful systems design applicable and beneficial in the indoor climate industry?

This study is based on a case from a company in the indoor climate industry called Swegon. In total, nine semi-structured interviews were conducted with people in managerial positions at Swegon. The questions were based on the areas of needed capabilities presented by Sayar & Er (2018). In order to further broaden the insights from this study, two complementary cases from the same industry with experience of IoT systems were also interviewed. The data gathered from the interviews was then coded into the same categories as in the framework to make comparisons with the literature.

The results show that the Sayar & Er framework is in most cases applicable and beneficial also in the indoor climate industry. However, three main alterations should be made to create a better fit. Firstly, redefined roles and responsibilities of the front-line personnel is not as important, while clearly defined responsibilities with partners is still needed. Secondly, guidance on system use should still be given to customers. However, this is not applicable for all customers but rather the industrial ones, which are typically more involved in the operations and uptime of the system. Lastly, the insights provided by Li et al. (2012) concerning industrial driving force and strategic intent for the IoT implementation should be considered. Industrial driving force refers to whether there is a market pull or technology push for the considered technology, while strategic intent is whether the firm is catching up with competition or getting ahead of it.

Keywords: IoT, internet of things, capabilities, indoor climate, digitalization, servitization

Preface

This master thesis was written in the spring of 2019 in collaboration with the indoor climate company Swegon. This assignment was the last step for us both to complete the master's programme Management and Economics of Innovation at Chalmers University of Technology. There are a number of people who we would like to give extra recognition, without your contributions this thesis would not have been finished.

We would like to thank our supervisor at Swegon, Fredrik Berntsson, for enthusiastic and never tiring guidance in the project. We would also like to thank all friendly coworkers of Fredrik at Swegon, both in Gothenburg and Cantarana, for welcoming us to the company. Furthermore, we would like to thank the respondents for the thesis, both at Swegon and the complementary case companies, for sharing your insights and making this thesis possible.

Lastly, we would like to thank our supervisor at Chalmers, Kamilla Kohn Rådberg, for interesting discussions and valuable insights throughout the process, and of course Chalmers University of Technology for five fantastic years.

Gothenburg, May 2019

Anton Alexandersson

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1 Introduction

1.1 Background

Digitalization has changed the world in several stages. Yoo et. al. (2018) describe this change as three *waves* of digitalization, the first being the emergence of computers, the second the arrival of internet, and the third the integration of internet connectivity in products. The last wave concerns a bundling of physical units and wireless network communication into the same device which is what Vermesan et. al. (2011) define as the Internet of Things, or IoT.

Lee and Lee (2015) identify five essential IoT technologies: Radio Frequency Identification (RFID), Wireless Sensor Networks (WSN), middleware, cloud computing, and IoT application software. IoT enables firms to innovate their operations, which allows for new areas of value creation. Lee and Lee (2015) have found three areas where IoT can be applied in a business setting: monitoring and control, information sharing and collaboration, and big data and business analytics.

As mentioned, IoT technology allows firms to remote monitor and analyze their products performance, which enables them to develop a closer relationship with their customers (Rymaszewska, et al., 2017). One way of doing this for the firm is to adopt a service strategy. For manufacturing firms, utilizing servitization strategy entails an extended *value chain* (Rymaszewska, et al., 2017). As described by Porter (1985), the firm's value chain stops at outbound logistics, when the product leaves the firm and is transferred to the customer. However, as IoT allows the firm to collect data from the product when the customer is using it, the value chain is extended to allow for more activities (Rymaszewska et. al., 2017).

Sayar and Er (2018) present six capabilities of successful IoT service and system design: Communicating a well-articulated system design strategy, redefining the roles and responsibilities of the frontline personnel, training and recruiting service aware staff, providing guidance to customers on system use, aligning customer focus across the business, utilizing methods/techniques for systems thinking and creativity (Sayar & Er, 2018). However, the same capabilities are not needed in all possible scenarios of implementation of IoT (Li, et al., 2012). When a firm is about to implement IoT in its products, it needs to make strategic choices on what approach to take.

1.2 Purpose and research question

The paper by Sayar and Er (2018) leads up to specific capabilities needed in the manufacturing industry, derived from examples of an aerospace company and a

truck company. It is however unclear if the same framework can be applied to other companies in the manufacturing industry. Therefore, this thesis will explore what benefit Sayar and Er's framework creates when it comes to assessing the capabilities of a manufacturing firm in the indoor climate industry. This has led to the following research question:

Is the Sayar & Er (2018) framework for capabilities for successful systems design, applicable and beneficial in the indoor climate industry?

1.3 Outline

The thesis is structured into a literature review, method, a case description, results and analysis, discussion, and lastly conclusion. In the literature review, sources on digitalization from a historical perspective, technology enabling IoT, business implications and value creation of IoT, and capabilities and challenges for IoT implementation is brought up. The section is concluded with the identification of gaps in the current literature, which leads to the research question of this thesis.

Then, it is explained how the research was designed, and what method was used. As a case company was studied, a qualitative method was used in the form of semi-structured interviews. The interviews were based on material from the literature review, and respondents selected based on their experience in the area researched. After the method chapter, the case company and the complementary case companies are introduced and explained.

After this chapter, the result from the interviews is presented in the form of a table with the main findings. In the same chapter an analysis of the findings is also presented with quotes from the interviews. Both the results and the analysis are structured according to the categories of the Sayar & Er (2018) framework. The thesis ends with a conclusion and managerial implications.

2 Literature review

In this section, literature on what IoT is, what it can be used for, and what firms need to use it will be reviewed. Firstly, the historical development of digitalization leading up to IoT is presented, followed by an assessment of the technologies enabling it. Later, activities which are made possible with IoT are reviewed, which concludes in the enabling of new business models. The activities enabled by IoT are therefore followed by an explanation of the business model known as *servitization*, and the benefits and costs of it is assessed. Then, the concept of a *value chain* is explained, and how IoT extends the firm's current value chain. Lastly, organizational capabilities needed for IoT implementation are reviewed.

2.1 Historical development

To understand the area of IoT, the historical development of digitalization needs to be considered. Digitalization has already changed the world in several stages. For example, menial labor is now automated, and the internet has become an essential part of people's everyday life. Yoo et. al. (2010) describe this change as three waves of digitalization, the first being the emergence of computers, the second the arrival of internet, and the third the integration of internet connectivity in products.

In the first wave of digitalization, information was converted from being analogue to becoming digital. This meant that information could be handled and distributed more efficiently. Even though this was an improvement in efficiency, it did not change industry structures, since firms could keep their business models (Yoo, et al., 2010). The authors refer to the second wave of digitalization as when the internet was introduced, which meant information could be spread even more rapidly. Internet also enabled changes in industry structures, as it worked as a medium for offering products and services. For example, online retail and downloading of music was enabled by the internet. Lastly, Yoo et. al. (2010) argue that the third wave of digitalization is taking place right now, in the mixture of networks and products. This transformation also enables new services and products. Yoo et. al. (2010) bring up the example of running shoes containing small computer chips, enabling the runner to collect and analyze data about their work-out. The bundling of physical objects and wireless network communication into the same device is what Vermesan et. al. (2011) define as the Internet of Things, or IoT.

Table 1: The three waves of digitalization according to Yoo et al. (2010)

First Wave	Second Wave	Third Wave
Analogue to Digital	The Internet	Internet of Things

2.2 The technology enabling Internet of Things and its business applications

To understand the possibilities of IoT technology, its technological components must be examined. Lee and Lee (2015) identifies five essential IoT technologies: *Radio Frequency Identification* (RFID), *Wireless Sensor Networks* (WSN), *middleware*, *cloud computing*, and *IoT application software*. Radio Frequency Identification (RFID), is a small computer chip containing information on e.g. the content of a package, which can be transmitted wirelessly using a RFID reader (Lee & Lee, 2015). Some RFID tags only contain a static set of information, while others contain sensors collecting data continuously (Lee & Lee, 2015).

A Wireless Sensor Network (WSN), is a collection of interconnected sensors, each measuring a specific variable such as location, temperature or movement (Atzori, et al., 2010). These sensors are relatively cheap, require little energy (Gubbi, et al., 2013), enables the owner of the network to optimize the use of the system and allows for preventive maintenance (Lee & Lee, 2015). Middleware is a software layer which coordinates the information from the various sensors into an interface. The interface can be used by developers for e.g. data analytics (Lee & Lee, 2015). There are open source middleware platforms which allows for the development of applications with little effort, such as Global Sensor Networks (Lee & Lee, 2015).

Cloud computing enables small computer chips to get access to remote servers (Lee & Lee, 2015). This means that manufacturers do not need to install computing power or memory locally in the chip, as it gets access to that through the internet (Lee & Lee, 2015). Cloud computing can take the shape of, for example, Infrastructure as a Service (IaaS), which means that the users of the service pay for using the infrastructure and do not need to own it themselves (Gubbi et. al., 2013). Devices connected to the Internet need to be able to communicate with other devices as well as humans. This is enabled by IoT applications, which can work as a communication channel between devices (device-to-device communication), as an interface for visualization of data, and as an interface for communication between humans and devices (human-to device communication) (Lee & Lee, 2015).

IoT enables firms to innovate their operations, which allows for new areas of value creation. Lee and Lee (2015) have found three areas where IoT can be applied in a business setting: *monitoring and control*, *information sharing and collaboration*, and *big data and business analytics*. The authors claim that an understanding of these areas is essential for a lucrative adoption of IoT.

Firstly, monitoring and control, according to Lee and Lee (2015), includes systems that gather data on performance, energy usage, and environmental conditions. Furthermore, these systems enable continuous tracking in real time, which can be done by managers or in automation. More advanced solutions can also detect patterns, areas of improvement or predict future outcomes. This can help lowering costs and increase productivity. Lee and Lee (2015) also highlight control and personalization for individual users as a key benefit of these systems.

Momeni & Martinsuo (2018) highlight business processes that can create business value from remote monitoring systems (RMS). Customer relationship management can use RMS to have less downtime and minimize costs by optimized maintenance and early problem detection. Marketing can get help from RMS to estimate benefits and costs for customers. Product development can make use of data from RMS to make customizations that better suits specific customers. RMS can also make it possible to offer customers performance enhancements after the initial sales offering. Lastly, the authors highlight that RMS can lead to creation of new business models. Reference data can be sold, and targeted services can be offered based on specific product use.

Remote monitoring of products gives information which can be used for what Rymaszewska et. al. (2017) call *condition-based maintenance*, or CBM. CBM is when repair decisions of a product are based on its current state, which means it is only repaired when it actually requires it (Rymaszewska et. al., 2017). This also results in enhanced uptime of the product, as it is always repaired before it breaks down (Rymaszewska et. al., 2017). As information on what is wrong with the product is accessible, the cost of repairing it is also lowered, since the maintenance personnel will not need to examine it on site and can prepare (e.g. bring the right tools) for the repair before coming to the site (Rymaszewska et. al., 2017).

Secondly, information sharing and collaboration can, according to Lee & Lee (2015), take place at different interfaces: between people, between people and things, and between things. These activities can direct attention to relevant areas and therefore avoid information delay and distortion. Lastly, big data and business analytics, according to Lee & Lee (2015), involves IoT devices equipped with sensors that generate a big amount of data that can be used to make business intelligence decisions. For example, alterations in customer patterns or in the business environment can be identified and adaptations can be made accordingly. This way, satisfaction for customers can be increased and new services can be developed.

2.3 Business implications of IoT

As mentioned, IoT technology allows firms to remote monitor and analyze their products performance, which enables them to develop a closer relationship with their customers (Rymaszewska, et al., 2017). One way of doing this for the firm is to adopt a service strategy. Mathieu (2001), acknowledges three main areas of benefits from applying a service strategy in the manufacturing industry: financial, strategic, and marketing benefits.

However, Mathieu (2001) presents two main costs that needs to be coped with by manufacturing firms that wants to take on a service strategy. The first one is *competitive cost*, which relates to the costs of acquiring new competitive advantages in the field of service offerings. The authors claim that these competitive advantages can be built in three ways: Using a driver of positional advantage, weakening the competitors' drivers, and developing new sources of competitive advantage the second cost is *political cost* which refers to the internal opposing that will take place during the shift to a new way of working. The authors present two examples of issues that reinforce political resistance: A service maneuver will be interpreted by the organization as an innovation, and the successful implementation of a service maneuver requires the adoption of service management principles.

For manufacturing firms, utilizing servitization strategy entails an extended value chain (Rymaszewska, et al., 2017). Porter (1985) describes the value chain of a company as a set of activities which create value for the customer. Stabell and Fjellstad (1998) further add to this framework that the product is what is transferring the value from the manufacturing firm to its customer. There are two types of activities in value chains: primary activities and supporting activities (Porter, 1985). The primary activities are the ones adding value directly to the product, while the supporting activities are enabling the primary ones (Porter, 1985). Porter (1985) defines five generic primary activities: Inbound logistics, operations, outbound logistics, marketing and sales, and service. He also defines four generic supporting activities, which are firm infrastructure, human resource management, technology development, and procurement (Porter, 1985).

Porter (1985) argues that competitive advantage comes from the value created for customers that exceeds the firm's cost of creating it. There are two main sources of competitive advantage: cost leadership and differentiation. The competitive advantage of a company often lies in one or more of its value chain activities, which is why the framework is a useful tool to understand companies (Grant, 2016). However, Grant (2016) also argues that in some cases, the framework can be too rigid and fail to account for vaguer and less defined activities which creates competitive advantage.

2.4 Value creation of IoT

As described by Porter (1985), the firm's value chain stops at outbound logistics, when the product leaves the firm and is transferred to the customer. However, as IoT allows the firm to collect data from the product when the customer is using it, the value chain is extended to allow for more activities (Rymaszewska et. al., 2017). These activities are *use solutions* and *operations services*, which means that the firm is able to offer its customer advice on how to use the product and to offer services related to the product (Rymaszewska et. al., 2017).

This is enabled by the data, which is generated through the products, which gives the companies better insights into its customers. Rymaszewska et. al. (2017) also suggest five ways in which data can create value: *Quicker product introductions*, *new business models*, *supporting customer success*, *product as part of a broader system*, and *data analytics* (Rymaszewska et. al., 2017).

Value can be created through quicker product introductions, since IoT products incorporates software into hardware products, allowing companies to release small improvements more frequently (Rymaszewska et. al., 2017; Porter & Heppelmann, 2015). As stated previously, the improved insights on customer preferences and behaviors, as a result of IoT, allows for new business models, creating new value (Rymaszewska et. al., 2017). Examples of new business models can be selling "power by the hour" instead of physical products to the customer, or access to customer data to third parties (Rymaszewska et. al., 2017).

Furthermore, value can be created through supporting customer success, since IoT enables companies to help their customers use their products more efficiently, enhancing customer value and therefore their willingness to pay (Rymaszewska et. al., 2017). Also, products connected to the internet allow them to communicate with each other, creating synergy effects and therefore enhanced value (Rymaszewska et. al., 2017). Lastly, data analytics provides deep insight into customer preferences and behavior and can provide important forecasts of trends (Rymaszewska et. al., 2017).

In summary, IoT can extend a manufacturing firm's value chain by using data (Rymaszewska et. al., 2017). The data can create value through quicker product introductions, new business models, supporting customer success, product as part of a broader system, and data analytics (Rymaszewska et. al., 2017). To realize the potential value of an IoT implementation, Sayar and Er (2018) means that a set of certain capabilities are needed.

2.5 Capabilities and challenges for IoT implementation

Sayar and Er (2018) present six factors of successful IoT service and system design: *Communicating a well-articulated system design strategy, redefining the roles and responsibilities of the frontline personnel, training and recruiting service aware staff, providing guidance to customers on system use, aligning customer focus across the business, utilizing methods/techniques for systems thinking and creativity*. The study covered two case companies, both of which were manufacturing and had recently implemented IoT in their products. The first case company manufactured airplane engines, and the second trucks.

The communication of a well-articulated system design strategy concerns both communication between the firm and its partners, as well as internal communication between different departments at the firm. In the external communication, the firm should form and manage appropriate partnerships. This means having joint discussion with partner companies, making e.g. operational roles, implications and requirements clear (Sayar & Er, 2018).

In the internal communication, the firm should adopt an integrated design approach with different departments. All stakeholders should be involved as early as possible in the design process, when their influence can be maximized. In the design process, IoT data should be used to create synergy between components, overcome resistance and explain what actions are needed. The result of this should be a shared understanding of concepts, goals and requirements within the project teams (Sayar & Er, 2018).

With redefinition of roles and responsibilities of the frontline personnel, Sayar and Er (2018) mean that the perception of the frontline personnel has to change. The traditional view has been that the frontline personnel don't possess the skills needed for back office operations, and that their only tasks should be to serve the customers to keep the products operational. However, the authors point out that the frontline personnel are the people in the firm with most knowledge about how the customer use the product and how they work in reality, and also has the most customer interaction. This will be accentuated when firms move towards servitization, which is enabled by IoT. The role of the front-line personnel should then be leveraged, so that their knowledge is used in reengineering the product and reassessing the offering.

Kindström, Kowalkowski, and Alejandro (2015) have identified two new responsibilities for when firms are moving towards servitization, which are deliverer of brand value and solver of customer problems. This means that the frontline personnel need both to be able to promote the brand for which they are working and possess the technical knowledge needed to solve the customers'

problems. The need for frontline personnel to promote the brand of the firm is further emphasized by Wunderlich, Wangenheim and Bitner (2012), who point out that a firm which is controlling its customers equipment needs credibility, and the best way to gain that credibility is through knowledgeable and approachable frontline personnel. They also conclude that the more trust the customer has for the company, the less control they feel they need to have over their products, and that a company giving a bad impression through its front-line personnel cannot compensate for that in other ways.

Training and recruiting of service aware staff is important as the focus of the company shifts from products to services, so that excelling in state-of-the-art services will be increasingly significant (Sayar & Er, 2018). Ulaga and Loveland (2014) also bring up three important attributes of sales personnel: the ability to engage deeply with customer operations, to be able to deal with the fuzzy front end of service applications, and networking skills for managing multiple stakeholders. The organization needs to realize the difference between providing service and products and recruit suitable personnel with skills in customer interaction and flexibility. The feedback gained in customer interactions from sales and service personnel should be used in system design reviews to improve the offering (Sayar & Er, 2018).

To achieve this, the knowledge obtained in the development of the IoT solution should be passed on to the service personnel. The service personnel should also know how the product is used in practice, to support the customer in using it in the best way possible, and they should receive continuous training in this to stay up to date.

Providing guidance to customers on system use entails that companies need to be more aware of more interactive users. This is because the users now can see their own data and make their own interpretations. In combination with the need for evaluating and improving the systems, the companies need to involve customers to make use of their insights and previous experience (Valencia, et al., 2015). This is essential in order to catch all requirements for new improvements (Holmlid, et al., 2017).

Furthermore, it is important to make use of visual tools in order to make it easier to for users to understand the insights, for example by graphs and diagrams (Valencia, et al., 2015). Another good idea is for companies to offer services in the form of consultation for experts within the field (Sayar & Er, 2018).

Companies can no longer only isolate their products from the customers systems but needs to know how it interacts with the system and help customers make good decisions based on the whole system. This would also include having dialogues

with the customers in order to enhance their skills rather than just spreading information and improvement orders (Sayar & Er, 2018).

Furthermore, the shift from selling products to services needs an aligned customer focus across the business (Sayar & Er, 2018). This means that the firm needs the ability to connect product and service perspectives, through working cross-functionally in information sharing and decision making. Zhang, Zhao, Voss, and Zhu (2016) also mean that firms should develop an integrated customer interface to streamline the customer experience by bringing all functions to the same standard.

Lastly, Sayar and Er (2018) emphasize the importance of considering both the technology and business aspects when designing an IoT system. The goal of this is to view the system as a whole, not as loosely connected parts, and can be achieved through an integrated approach of controlling the systems design process (Sayar & Er, 2018). The beginning of the design process, the Fuzzy Front End, is characterized by e.g. unclear perceptions of customer needs (Nobelius & Trygg, 2002). To reduce the uncertainty in that phase of the development, Sayar and Er (2018) suggest the firm to formalize the methodologies used to understand customer requirements. Lastly, Sayar and Er (2018) mean that firms should use tools for idea contribution, such as rewards and incentives, to create an innovative culture. In summary, these six factors are according to Sayar and Er (2018) contributing to a successful IoT implementation and can be viewed in Table 2.

Table 2: Capabilities needed for IoT implementation (Sayar & Er, 2018)

Communicating a well-articulated system design strategy • Form and manage appropriate partnerships • Integrated design approach with different departments • A shared understanding of concepts, goals, and requirements within project teams
Redefining the Roles and Responsibilities of the Frontline personnel • Change the perception of the frontline personnel • More customer-focused frontline personnel • Clearly defined responsibilities with partners
Training and Recruiting Service Aware Staff • Be aware of difference between selling services and products • Spread the knowledge gained in the design phase to the sales & service reps
Providing Guidance to Customers on System Use • Make use of customers' knowledge and experience

• Help customers interpret the data • Help customers make good decisions based on the whole system
Aligning Customer Focus Across the Business • Ability to bridge product & service perspectives • A corporate system to bring and align all functions to the same standard
Utilizing Methods/Techniques for Systems Thinking and Creativity • Integrated approach to control the systems design process • Formalized system methodologies to control the Fuzzy Front end to understand customer needs • Use tools for enabling idea contribution

However, the same capabilities are not needed in all possible scenarios of implementation of IoT (Li, et al., 2012). When a firm is about to implement IoT in its products, it needs to make strategic choices on what approach to take. Li et. al. (2012) illustrate the possible scenarios as dependent on four factors, which can be seen below in Figure 1: whether the change is a market pull or a technology push, and whether the firm is ahead or lagging behind of its competitors. Market pull is when the customers expressly demand a new product, as in opposite to technology push, which is when a firm offers a product which customers not explicitly demand.

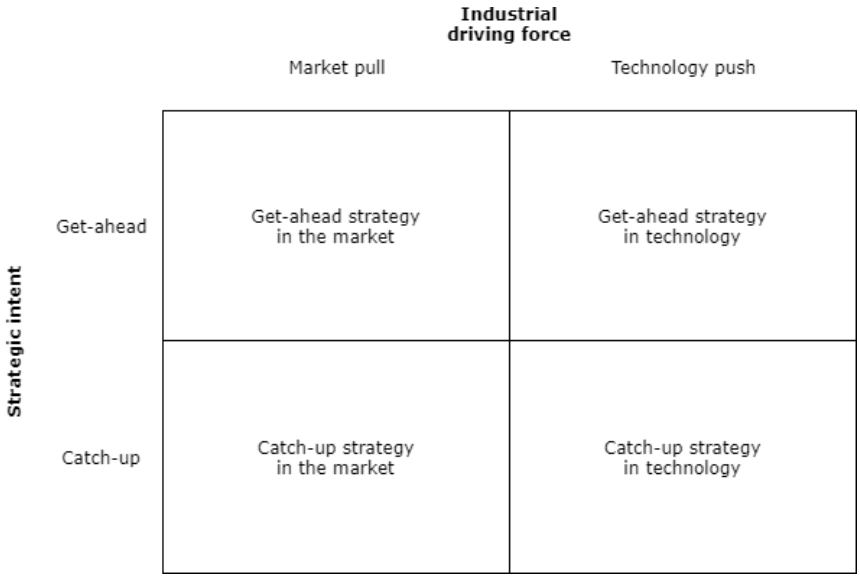

Figure 1: A typology of IoT strategic decision (Li et. al., 2012)

Furthermore, Li et. al. (2012) claim that for each strategic scenario, different capabilities are needed from the firm. In the case of Get-ahead strategy in market, the firm needs to sense the market and allow for a broad search of new technologies to integrate into the organization (Li et. al., 2012). Get-ahead strategy in

technology, on the other hand, requires the firm to be able to differentiate and further develop the existing technology to achieve competitive advantage (Li et. al., 2012). Furthermore, if the firm is using the Catch-up strategy in market, it needs to be able to effectively distribute resources for investments in IoT applications (Li et. al., 2012). Lastly, for firms using the Catch-up strategy in technology, capabilities for enhancing, but not radically changing, the current product with IoT technology is needed to establish competitive advantage (Li et. al., 2012).

In addition to the capabilities needed for IoT implementation, Lee & Lee (2015) introduce five challenges that will be present for companies interested in developing IoT solutions. These are data handling, data analytics, data privacy, data security, and incompatibility of systems. Firstly, IoT will create a vast amount of data which needs handling. Processes which that generally do not fit the structures of companies' data handling units. Furthermore, only a very limited number of companies will have the financial muscles to be able to invest in the data storage needed.

Secondly, the data stored and processed needs to be analyzed. According to the authors, the use of new data mining tools becomes essential since traditional ways of working are not fully applicable. Thirdly, companies involved in IoT needs to be aware of the privacy of their users. As mentioned, a lot of data can be gathered, of which some is personally sensitive. On the other hand, increased availability of data can lead to better service quality. Companies therefore needs to balance these two aspects (Lee & Lee, 2015).

Fourthly, as more devices become connected to the internet through IoT technologies, the risk for cyber-attacks also increases. Due to the lack of encryption and vague software protection, sensitive personal data can be stolen. Lastly, the authors present the risk of IoT creating chaos for businesses. IoT solutions are developed faster, have several standards, are interconnected with other devices, as well as other mentioned flaws. If the technology is not managed correctly it risks creating chaos even though just a small part of the system breaks down (Lee & Lee, 2015).

2.6 Research question

As mentioned in the literature review, the study by Sayar & Er (2018) has been conducted related to organizational capabilities needed for IoT implementation. The paper leads up to specific capabilities needed in the manufacturing industry, for examples from an aerospace company and a truck company. The companies studied by Sayar and Er (2018) were both present within the field of transportation. Because of this, it is unclear if the same framework can be applied to other manufacturing companies. Therefore, this thesis will explore what benefit Sayar

and Er's framework creates when it comes to assessing the capabilities of a manufacturing firm in the indoor climate industry. This has led to the following research question:

Is the Sayar & Er (2018) framework, for capabilities for successful systems design, applicable and beneficial in the indoor climate industry?

3 Method

In this section, the method used in the research will be explained. Firstly, the research design will be presented, followed by the methodology of the study. Lastly, it will be presented how the data collected in the study was analyzed.

3.1 Research design

To answer the research question, a case company was studied. To get broader insights from the indoor climate industry, two complementary companies, company A and company B, which use IoT were also studied. The main focus of the study was on the case company Swegon, while the answers from the other two were used for validating the findings at Swegon. As the research question aims to explore whether a framework is applicable in an industry, it requires a deep insight into the practice of the organization, which is why qualitative data rather than quantitative was used.

To extract qualitative data from the studied organization through a case study, interviews were conducted. There are three types of interviewing techniques: relatively unstructured, semi-structured, and relatively structured (Denizin & Lincoln, 2017). Relatively unstructured interviews are basically conversations with as little preparation as possible, while relatively structured interviews aim to ask exactly the same questions in the same way to all respondents without allowing for spontaneous follow up questions (Denizin & Lincoln, 2017). Semi-structured interviews on the other hand, is a middle road in which questions are prepared beforehand, but the researchers still may dig deeper into topics discovered in the interview which seem interesting (Denizin & Lincoln, 2017). In this study, both structure and flexibility are needed, since more structure ensures that the research questions are answered while flexibility allows for discoveries of unanticipated findings. Therefore, semi-structured interviews were conducted.

3.2 Methodology

As mentioned, semi-structured interviews were used to answer the research question. Two interview templates were developed based on two different articles, and can be found in Appendix A and B. The reason behind having two different interview templates was to fit their respective present IoT maturity, in which Swegon is undergoing a transition to IoT while company A and B already have made the transition to IoT. Therefore, the template for Swegon (Appendix B) aimed to explore specific pre-determined capabilities, while the template for company A and B aimed to be more open ended and see what the companies did well. The first template was based on six categories concerning important capabilities when designing IoT services and systems. The six categories were derived from the framework developed by Sayar & Er as presented above:

- Communicating a well-articulated systems design strategy
- Redefining the Roles and Responsibilities of the Frontline Personnel
- Training and Recruiting Service Aware Staff
- Providing guidance to customers on system use
- Aligning customer focus across the business
- Utilizing Methods/Techniques for Systems Thinking and Creativity

As explained above, the second interview template (Appendix A) was designed to be more open ended in terms of what capabilities are explored. Therefore, it was based on what value can be created by IoT, rather than the pre-determined capabilities in the first interview template. The second interview template was therefore based on five categories concerning ways to create value using IoT, derived from the framework developed by Rymaszewska et al. and are:

- Shortening the product development cycles
- New business models
- Supporting customer operations
- Product as a part of a broader system
- Data analytics

When formulating the corresponding questions, the aim was to not affect the answers of the respondents, also known as reducing bias (Easterby-Smith, et al., 2015). Therefore, most of the prepared questions were open-ended in order to give the respondents a chance to develop their thoughts instead of having to give short answers, as well as not being steered in any direction (Easterby-Smith, et al., 2015). The open-ended questions were then followed up with more specific ones when interesting areas were brought up by the respondent.

Other than the specific questions derived from the two frameworks, general questions about the respondents' backgrounds were formulated as well. This was both to receive information about the respondents and give the chance to the respondents to get a soft start to the interview to build trust, which is important when conducting interviews (Easterby-Smith, et al., 2015). In the end of the interview, each respondent was asked if they had anything to add other than what had been discussed in the interview.

When all questions were formulated, the questions were rearranged to create a more natural flow in the interview. For example, in the first interview template the questions were rearranged from the six categories into five more intuitive categories, being Design, Front-line personnel, Competencies, Data analytics, and Techniques for creativity. This was needed since several of the original categories contained questions regarding e.g. frontline personnel, which is why all questions on the same topic was gathered at the same place in the interview template.

A total of eleven interviews were conducted with eleven different interviewees. Eight interviews were conducted using the first interview template concerning capabilities and three interviews were conducted using the second template concerning value creation. Each interview was conducted by two interviewers where one had the responsibility for the main questions and the other for stating follow-up questions and taking notes. Each interview was also recorded with consent from the interviewees to make sure that no details were misunderstood.

During the interviews, both authors attended as interviewers, of which one followed the interview template while the other took notes and asked follow-up questions depending on what the interviewee answered to the original question. This reduced the risk for misinterpreting the interviewees' answers and enabled both the flexibility of follow-up questions and the structure of the prepared interview template.

The interviews at Swegon were held with representatives from the company in managerial positions, and the respondents were chosen based on their knowledge and experience within the interview template categories. In order to find identify these subjects, a discussion with the supervisor at Swegon was held. Respondents from several different functions in the company were selected to obtain a comprehensive overview of the company's capabilities. Five subjects were chosen prior to the first interview and three more were added in order to get more data in some categories. The subjects were then contacted on behalf of the supervisor in order to schedule interview times. The ambition was to conduct the interviews physically but when that was not possible a call was set up.

The interviews concerning value creation were held with representatives from three different companies. One respondent was responsible for System Development at a corporate level at Swegon, and the two other works at companies within the indoor climate industry with previous experience in IoT services. These interviews aimed to get a broader perspective of what is possible through IoT solutions and what it requires.

Table 3: Respondents participating in the study. Where the language is marked with and asterisk the interview was conducted in the respondent's native language. Interview template B was used for all respondents except the ones typed in italics.

Title	**Company**	**Language**	**Means**
Customer Service Manager	Swegon Cooling	English	Physical
Software Development Manager	Swegon Cooling	English	Physical

Sales Director	Subsidiary A	English	Physical
Product Manager	Swegon Cooling	English	Physical
Head of Service	Subsidiary B	English*	Telephone
Business Developer/ Controller	Swegon Cooling	Swedish*	Skype
Business Development Director	Swegon Cooling	English	Skype
Technical Manager	Subsidiary C	English	Skype
Director of R&D	*Company A*	*Swedish**	*Physical*
Chief Technology Officer	*Company B*	*Swedish**	*Telephone*
System Development Director	*Swegon Corporate*	*Swedish**	*Telephone*

3.3 Data analysis

All interviews were recorded and later transcribed, to enable better analysis of the data (Easterby-Smith, et al., 2015). The audio files were transcribed word for word, but other verbal utterances, silences and hesitations were not noted.

The transcribed data from all eleven interviews was coded into the six categories about needed capabilities, to be able to better analyze it. This was needed since, although each interview question aimed to collect information on a specific category, data on several different categories was sometimes received in a single answer.

At first, long segments of the transcribed data were coded into the different categories. Then, the data was read through again, to find vigorous quotes in the text, which then were summarized for each category. The quotes in each category were further broken down and sorted into the components of each category, to enable further analysis of the data.

When the transcribed, coded and sorted data set was complete, a comparative analysis was initiated to find differences in statements from different interview subjects. When differences were found, they were analyzed to conclude which statement was deemed to be true, based on the knowledge and experience of the

interview subject and whether the subject had any reason not to tell the truth. Such reason could be not to lose face, as described by (Argyris, 1976).

Then, the data was compared to the findings in the literature review, to find any differences between Swegon's capabilities and the ones suggested by the literature. This was done in order to assess the applicability of the Sayar and Er framework in the indoor climate industry. After the findings had been analyzed and discussed a conclusion was written in order to answer the research question presented.

4 Case description

In this section, the case company subject to the study is presented. Firstly, the company and its products are described, followed by a presentation of the company's shift towards IoT. Then, the value chain of how the company sells its products is examined. Lastly, two complementary cases used to validate the results from the case company are presented.

4.1 Swegon

Swegon, a Swedish company with 2200 employees owned by the investment firm Latour, develops products and systems for energizing indoor climate. Their competences range from ventilation to cooling and they have multiple offerings for their customers. The company consists of several divisions, one being Cooling & Heating, which is the one investigated in this thesis. This subset of the company develops cooling and heating products for facilities, both industrial and non-industrial. Within this business area, Swegon has a factory in which it produces cooling machines.

The factory sells the cooling units to its subsidiaries, which are responsible for further distribution. There is typically one subsidiary for every country in which Swegon has market presence. The subsidiary either sells the cooling machines directly to the end user or to a third-party firm, e.g. an installation consultant. The subsidiaries are also responsible for servicing the machines in their markets during the warranty period.

Every cooling machine consists of several mechanical components that makes sure that the air or water has the right temperature. Furthermore, the operation is tracked with the help of sensors and software. These parts are referred to as physical and smart components (Porter & Heppelmann, 2014). Lately, Swegon has started using a supervision system for its cooling machines, which is called BluEye. The BluEye is produced by a third-party company and connects to one or several machines and connects them to the internet. As the BluEye is an off-the-shelf product produced by a third-party, it is able to connect to any machine having an internet port.

4.2 BluEye

In essence, BluEye is a simple card which can read variables through an internet port connected to a device using a specific communication protocol. Therefore, BluEye can be connected to any other device using that protocol, even though it is not produced by Swegon. Furthermore, devices not using this protocol can also connected using a gateway as a converter. Mainly, the devices have been fitted into Swegon's own units but there are some examples where customers have used it for their own application, such as an inverter or gas burner. A single BluEye can be connected to up to five or ten devices, depending on the version.

The BluEye unit needs a power outlet and an internet connection to function. The unit is fitted inside the device it monitors and outside an antenna and a switchboard is placed. For smaller or special devices, there are also variants of the BluEye where all components are inside a box which can be attached externally. Once the installation is finished, the unit communicates with the cloud, which is provided by the third-party manufacturer along with a complementary web-based tool.

Swegon pays both for the hardware and the cloud-based service along with the web interface. The hardware is bought for a one-off price and the service is paid with an annual fee. The services come in two different variants: a cheaper, basic, version and a more expensive, advanced, version. The services vary in terms of the number of variables one can monitor and the reading frequency. The advanced version allows more monitored variables and a higher monitoring frequency than the basic one. It is possible to change between the two different service levels.

For each application of the BluEye unit, one needs to choose which variables to monitor and what alarm triggers to set up. For example, the temperature, pressure, water flow, and electrical consumption can be monitored. The data can also be recorded in order to plot trends over time. Furthermore, alarms can be set up to go off, for example, when there is no water flow or when the temperature is outside the accepted limitations.

Apart from the presented services, BluEye is also able to establish a VPN connection. This means that, for a fee, an external user can remotely get into the controller. This enables a service technician or software developers to, not just track variables, but also to modify settings. New software can also be uploaded and installed remotely, allowing for complete reprogramming of the controller.

As mentioned, the web-based application can be used to access the BluEye connected units. To do this, the user needs login details that are granted access. There are different levels of authority for different users. In order to be able to be able to do more advanced actions, like changing settings, the user needs to have administrator access. In order for the customers to be independent, being able to do modifications themselves, Swegon wants them to have at least one administrator in their own organization.

When opening the web application, the user can see which plants are online, which are offline, and which have alarms. Online means that the plants are working correctly. If the unit is offline it can be due to lack of power or no connection to the internet. Alarms are triggered when problems occur, or parameter values are below or above certain levels. In order to get specific details on the plants' status, the user can visit its individual page.

Swegon's subsidiary B has decided to include a BluEye in all new units above a certain cost. There are also BluEye units that are operated by the technical department in order to develop new solutions. Furthermore, some units can be deployed temporarily when the customers encounter more difficult problems. This enables Swegon technicians to monitor the operation of the plants for a longer period, and thereby finding the problem, without having to stay in front of the unit.

4.3 Value chain

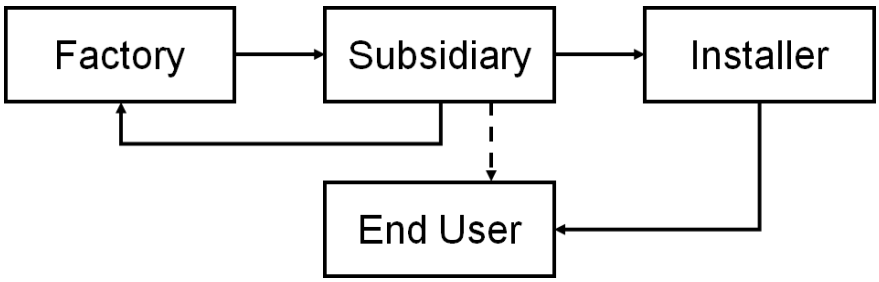

Figure 2: Cooling machines value chain

The cooling factory manufactures the cooling units and sell them to the local subsidiaries. The subsidiaries then distribute the goods, either to an installer or directly to the end user. Whenever a problem with a unit occurs, the owner of it calls their seller to file a complaint. In other words, they do not call the factory directly. The sellers then try to repair the unit. If they are not able to do so, they will get in contact the after sales department at the factory, as displayed in Figure 2.

The end users can be anything from industrial manufacturers, for which the indoor climate can be critical for production, to office occupants. As the factory does not sell the systems directly to the end users, but has one or two intermediaries between them, the end users are often hard for the factory to identify.

The end users, unless they are responsible for the maintenance themselves, generally are not interested in the cooling machines other than that they should work as they are supposed to. They have other responsibilities to take care of and pays a monthly fee for the indoor climate to be good. How the unit is kept in operation is not their concern. This is, however, not the case for some industrial end users, for which the indoor climate is crucial for production. They are generally more interested in knowing more how the machines work, to be able to work proactively to keep them running.

When a new unit is sold, the subsidiary which sells it offers a period of warranty to the buyer, during which the subsidiary is responsible for keeping the unit operational. Each subsidiary can create their own warranty conditions with the customers or the installers. As described above, the subsidiaries sometimes sell the

units to installation consultants, which then sells them to the end users. In that case, the end user will first contact the installation consultants for service during the warranty, who then have the option to go on site or to contact the subsidiary for assistance. In cases when the subsidiary is unable to solve issues for the end user, they contact the after sales department at the cooling factory to receive assistance. In this case, BluEye can be used by a factory service technician to give advice to the subsidiary remotely. Troubleshooting might be possible to do off-site and therefore tools and spare parts can be prepared before a trip to the customer.

When the warranty expires, the end user will be responsible for the unit's well-being, and also has to pay for the service. Either the end users sign a service contract with the subsidiary, or they take care of the maintenance themselves. In the former case, the subsidiary takes care of the maintenance for an annual fee.

4.4 Complementary cases

Company A develops and offers a service for facility energy optimization. The company aims to offer the best indoor climate using the least amount of energy possible. More specifically, company A coordinate the operations of the several systems in a facility in an optimal way using connected units and cloud stored data. In other words, the company does not offer the cooling, ventilation, or heating system but connects to them to control. The service is mostly sold to facility owners or the companies responsible for controlling the indoor climate systems.

Company A was previously a part of a construction company but was separated from its mother company when management realized their value proposition was viable to be ground for a company of its own. The optimization tool was previously offline in each building but is now connected to the internet to centralize data storage and analysis in the cloud.

Company B works with optimization of district heating for several actors in the value chain. They are also offering efficiency optimization for indoor climate solutions. Their main customers are energy companies but also facility owners. To provide this to their customers, the company offers an IT-system as a service. However, they are not replacing other present automation systems, but they rather complement them. The company was started as a spin-off from a research project at a Swedish university and still has a close relationship with academia today through joint development projects.

5 Results and analysis

This chapter of the thesis will present the findings from the conducted interviews. A summary of the findings can be found in Table 4 structured by the framework categories provided by Sayar & Er (2018) which can be found in Table 2. The rest of the chapter follows the same structure but will present the findings in more detail using quotes and also provide an analysis.

Table 4: Findings from the interviews. Findings from the complementary cases in italics.

Category	Findings
Communicating a well-articulated systems design strategy	• Input for new products from Sales Manager and Product Manager • Reports are filed when product issues are resolved • Several actors involved in the development process • Some cross-functional product development • Meetings to resolve disagreements • First units of new versions are used as prototypes • Visualized milestones prior to commenced development • *Selling systems through partner network* • *Product council sets system requirements*
Redefining the Roles and Responsibilities of the Frontline Personnel	• Mixed perception of the importance of frontline personnel insights • Frontline personnel insights transferred back to the factory through the customer service department • Subsidiaries argue that frontline personnel need to be customer focused technical experts

	• The knowledge of BluEye among the frontline personnel varies • Service personnel is trained and assisted by an expert team at the factory
Training and recruiting service aware staff	• Several actors claim that good communication with customers is needed • BluEye can enhance customer communication • The service personnel are trained by the factory • *The IoT solution improves the customer contact*
Providing guidance to customers on system use	• End user lack interest in providing feedback • The end users are hard to identify due to the long value chain • Visualized data insights to customers • Lack of capabilities to handle large data sets • Combination of recommendations and education • *Proven capabilities in data analytics*
Aligning customer focus across the business	• Regular discussions and decision making between some functions • Standardized communication within the company • Appointed main contacts at the factory for handling subsidiary communication
Utilizing methods/techniques for systems thinking and creativity	• Cooperation between functions to enhance the result of the system • Informal methods to understand customer needs

	• Meetings with the subsidiaries obtain ideas • Different degree of communication with end users between subsidiaries

5.1 Communicating a well-articulated systems design strategy

To communicate a well-articulated systems design strategy, as presented by Sayar & Er (2018), companies should fulfil three sub-requirements. Firstly, companies need to form and manage partnerships with external actors by having joint discussions about e.g. roles and requirements. Secondly, an integrative design approach involving different functions should be undertaken, where stakeholder should be involved early and IoT data utilized to find synergies. Thirdly, it is important to create a shared understanding of concepts, goals and requirements by providing clear descriptions (Sayar & Er, 2018).

5.1.1 Form and manage appropriate partnerships

Both the Software Development Manager and the Business Developer explains that the requirements of new products or software are formulated by the product manager or the marketing department. The product managers discuss with the sales companies to reach a conclusion on what to prioritize. The requirements are often based on what Swegon senses that its competitors have, and they do not. The technical department first decides on the design of the hardware, and then the software department designs software for it. This is illustrated in the quote from the Software Development Manager below:

> *"We have the marketing and the system they have everything, but the software department is not involved [in setting requirements]. It's just which kind of unit we need to do, what the competitors have, and we don't. And they realize what the cooling machine should be at, should have. And in that case, from these ideas, all starts, because the technical department starts to think how we can try to make this kind of unit, is it big, is it small, this is the lineup of sizes and so and so. And move to the first draft of the software department, and we can start to work."*

The Customer Service Manager requires reports to be written by the front-line personnel when problems with the units are discovered, so the knowledge about what is wrong and why it is wrong can be documented. In return for this report, the cooling factory sends spare parts for free to the subsidiary. The quality department of the cooling factory then receives the report and can act to improve the products:

"Why do we do this? Not because we don't trust our partner, but because our quality department has to understand what is going wrong. To be able to take some actions to improve the product, or even, not only the production but also maybe the quality of the components we use."

The Director of R&D at company A explains that they sell their solution through a partner network, which installs the system for the customer. The partners also cooperate with company A in advising the customers on how to improve the energy efficiency of their properties and suggests improvements for product development. The cooperation between company A and its partners means that both parties can focus on what they do best; company A can focus on improving its system which automate facility management, and its partners can focus on operational tasks which are too complicated to be automated. The CTO at company B also describes how they are cooperating with partners. With their partners, they have joint innovation projects for new product development. Like company A, they partner up with companies in the field of facility automation, which can sell and install their systems to property owners.

5.1.2 Integrated design approach with different departments

The software development process at the cooling factory consist of twelve steps, which are: Input from product manager and sales manager, feedback from R&D, specification, analysis, draft development, documentation, development, prototyping, debugging, beta testing, debugging, and production which can be seen in Figure 3. In the specification, both the software developers and thermo engineers are involved. Three different types of software can be produced: applications, HMI (human-machine interface), and websites, but the trend is towards applications and websites, and away from HMI.

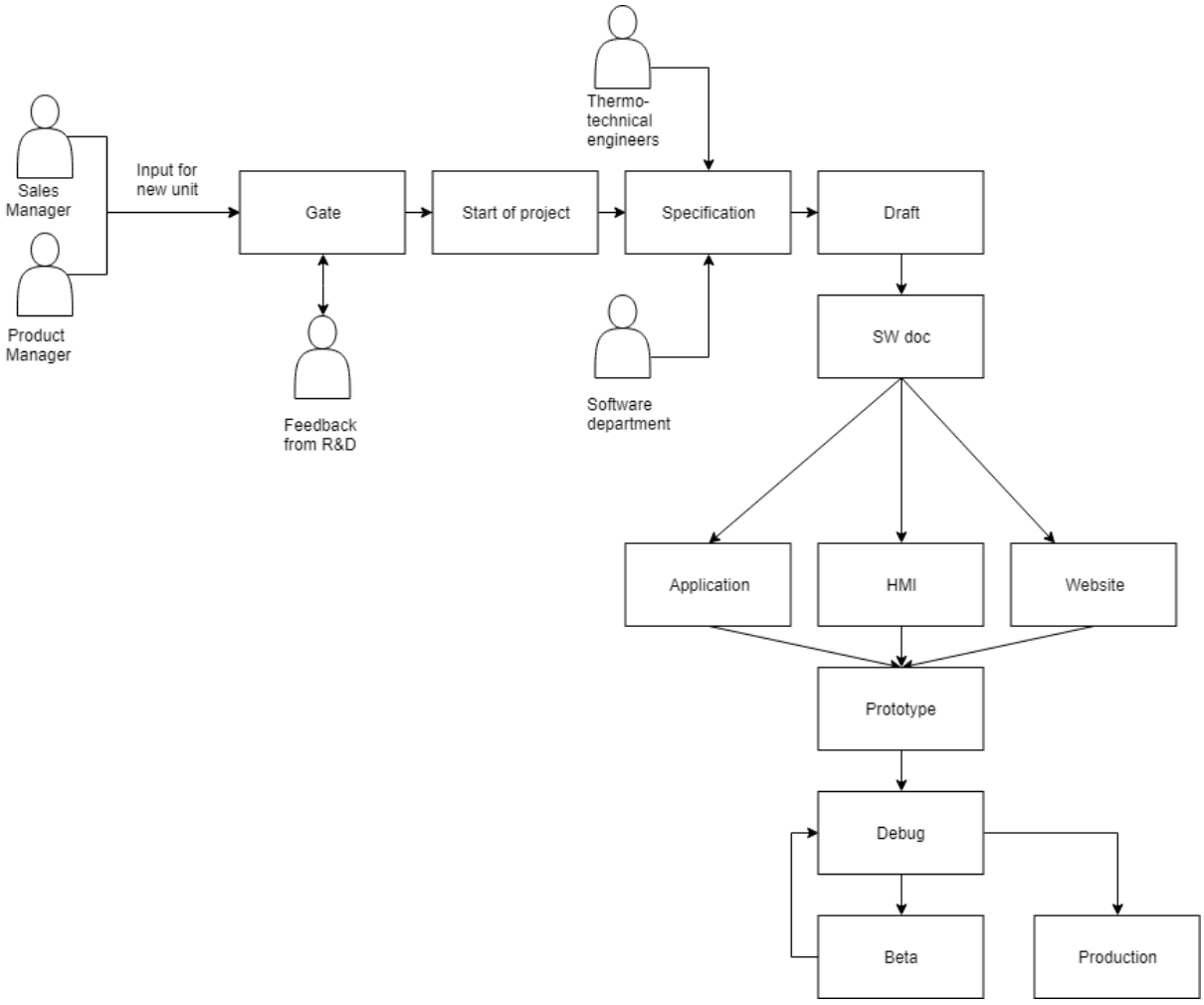

Figure 3: Software development process at Swegon cooling

Both the Software Development Manager and the Business Developer explained the importance of cross functional cooperation between departments. The Software Development Manager means that the software department needs to both give input to the thermo-technical engineers on what they can achieve through new functionality in the software and receive input from electrical engineering on what constraints they need to put on the software. The business developer means that the product managers bridge between e.g. software and thermo-technical engineering. The quote below from the software development manager describes this:

> *"For us it is very important to give them* [the thermo-technical engineers] *all the possibility about discovering a new way for us to be high performers of our units, so the software basically is the vehicle about the new research for the thermo-technical engineer"*

When members of the team don't agree on what is to be done, the Software Development Manager strives to reach consensus. In a situation when all team

members do not agree, an extra meeting is planned in which all team members get a chance to explain their different points of view and motivate their reasoning. The software manager demands objective arguments for the different points of view, which usually leads to a unified opinion in the department.

> *"Sometimes there are people who has a different idea. But I think that the consensus could be a strategy. For example, for analyze what is better or not, ok? So, all the people say what they think, their suggestions. But, if someone has a different idea, maybe it is better to spend one more meeting and try to understand, if it is very different, why?"*

The Business Developer, the Product Manager, the Software Development Manager, and the Customer Service Manager all explain how the company can use the data collected from BluEye in the product development process. This is mainly through installing the BluEye in the first few machines in a new product line, to be able to monitor them when used in the field. The Technical Manager at subsidiary C also emphasizes that BluEye can be used during the commissioning phase to make alterations of parameters. This is necessary since the machines can't be tested for all conditions in the lab. The Software Development Manager explains this in the quote below:

> *"But this requires a lot of time in the testing room, monitoring the data, but this is the way how we can push a lot about the collect the data, from the field. Because in the testing room you see half an hour is the same external world but during when you have the unit on the roof for one year, you see the chiller in summertime in winter, what has happened to the unit with different requirements."*

However, the Business Development Director do not agree that the data can be used for product development on a larger scale, since the BluEye is not enough widespread yet, and the company therefore has too little data:

> *"I think potentially yes* [we can use insights from BluEye in product development], *but this is a bit theoretical, but it basically means that if all your units, at least a very large majority, should be equipped with a BluEye because you cannot base a product development on few units."*

At company A, the Director of R&D explains that the input for new products comes from a product council, in which upper management is present along with other selected parties, which enables a cross functional approach to product development:

> *"It's the product council really, and that consist of ourselves and it can be more strategic matters coming from senior management, and it can be input from our energy technicians, input from technical support, input from the*

software developers, telling that something is causing problems for us or that there is technical legacy which we have to work on. It comes from several different directions, and then it's prioritized in the product council and some sort of compromise is worked out, a priority queue."

In summary, it is found that several actors are working cross functionally in the development process at Swegon. Also, when disagreements occur, extra meetings are used to resolve them. Furthermore, it is found that Swegon use the first units of a new version as prototypes for further development, using the BluEye to monitor them. Lastly, it is found that company A uses a product council to receive input from several different stakeholders to set system requirements of new products.

5.1.3 Common understanding of concepts, goals and requirements

Before the software department starts to write any code, it is discussed internally what the goal of the project is, and milestones are specified. The milestones describe the project's expected parts. The milestones are then visualized on the wall before any code is written, so that everyone is clear on what is to be done, the Software Development Manager explains:

"The tools, for example, for the visual planning of the project, it's the ideas, my ideas, the project has to be ecological. Something that has to be clear and good for everyone about the team. But also, if someone, just a small group of people, would be a small project. But we can increase the number of the people in the beginning, about the briefing or brainstorming or whatever, and we have the good here to start with something new. About the expected parts. And for this is the milestone for our department, to start with not much briefing, but start with deeply briefing, and start with internal discussion about the project. And move to write down some milestones that we have to do and visualize it on the wall. Because we need to visualize before we start. We don't write any line of code, before it has to be clear, every part of the project. Sometimes we start, and we did because, this is details and not so important, but the backbone of the team has to be clear. Sometimes we the same with the planning."

5.2 Redefining the roles and responsibilities of frontline personnel

To have redefined the roles and responsibilities of the front-line personnel as suggested by Sayar & Er (2018), requires companies to take actions of improvement in three areas. Firstly, the perception of the frontline personnel needs to be changed in order to realize that they have a lot of product knowledge and customer insights that can be used to design new offerings. Secondly, the frontline personnel need to be customer focused which involves solving customer problems

using knowledge in e.g. IoT but also to deliver brand value. Thirdly, it is important to clearly define the responsibilities of each partner to make sure that each actor knows what to focus on in order to enhance the customer experience (Sayar & Er, 2018).

5.2.1 Change perception of the frontline personnel

Both the Sales Director at subsidiary A and the Customer Service Manager thinks that the frontline personnel have more responsibilities than just solving customers' technical problems. The Customer Service Manager sees that the front-line personnel's' technical knowledge is valuable in improving products and require them to send him a report on the details of an issue when they discover one. The Sales Director at subsidiary A explains that they can promote sales for Swegon because of their vast customer contact, as seen in the quote below:

> *"[Their responsibilities are] to collect information, check systems, but sometimes it is the same people that is in a relation and contact with the customer, so they are able to promote also the sales about this."*

The Business Developer, the Sales Director at subsidiary A and the Head of Service at subsidiary B all explained how the knowledge from the front-line personnel can be transferred back to the company for further improvements. However, the Business Developer thinks that that they can improve their ability to transfer knowledge from the frontline personnel to the company and explains that there are initiatives in place to include the front-line personnel in the company more. The Head of Service at subsidiary B explains how the knowledge transfer is conducted today:

> "*If we [service personnel] find some that is a recommendation to improve then we'll put that back to our product groups and back into the factory. I, and our area support managers have generally regular communication with the factory."*

The Software Development Manager agrees that there are channels for the front-line personnel to submit their ideas for further product development back to the factory but means that those channels are seldom used. This is, according to him, because they would need a better understanding of how the products are working to be able to make suggestions, as described in the quote below:

> *"We could get a lot of important information from the service but it's maybe not something that we have at the moment to be honest, right now. I think the service guys focus on one thing, and the software team have a different focus. And I would like to get more feedback from them but it's not so easy because they have a different focus, a different experience, different skills*

and different characteristics. This is not what we can teach them because we are talking about attitude, enthusiasm, this kind of matter."

5.2.2 More customer focused frontline personnel

The Software Development Manager is aware of the importance of getting insights from the field. He mentions that when the software developers or people from the R&D department goes on site, they always come back with valuable feedback on how to improve the products. The reason, according to him, that the software developers and the people from the R&D department get better insights is that they have better knowledge about how the product works, and that enables them to better see what to improve.

> *"We receive a lot of suggestion when the software developers or R&D people are on the field.* [...] *When you want to know something, and you are able to recognize what this is, because you know exactly how it is made. "*

The Business Developer, the Technical Manager at subsidiary C and the Head of Service at subsidiary B all think that it is the responsibility of the front-line personnel to keep the plants working to their best occasion. However, the Technical Manager at subsidiary C explains the importance of offering a good service experience to create a good marketing position for BluEye. The Head of Service at subsidiary B also thinks that it is important that the front-line personnel provide a pleasant customer experience and that the front-line personnel promote the Swegon brand:

> *"If you look at the wider picture, it is promoting the brand of Swegon, and making sure that the customers feel that their experience is superior at all times."*

The Business Development Director and the Business Developer both means that the knowledge about BluEye varies among the front-line personnel. The Business Developer points out the market served by subsidiary B as a country which excels in this area. The Head of Service at subsidiary B means that 10% of his workforce are high level professionals in BluEye:

> *"We have sort of a good fortune to service professionals in [market B], and I'd probably say 10% of those are becoming high level experts on BluEye. The others, it's obviously clear that they need the education."*

5.2.3 Clearly defined responsibility of partners

The Business Development Director, Business Developer and Customer Service Manager explains the different service level and how an errand is escalated. Firstly, the service organization in the country where the case is tries to solve the problem, and if they cannot the service organization at the cooling factory supports them.

The Customer Service Manager also explains that apart from supporting the different service organizations they are responsible for preparing manuals for the service organizations on the machines' functionality:

> *"But it's mainly the time we have to spend to prepare the documentation. And unfortunately, the documentation is vast. Not the common manual you can find in a chiller you buy, but the documentation related to the training to the service guys."*

5.3 Training and recruiting service aware staff

As mentioned in the Sayar & Er (2018) framework, companies designing IoT systems should conduct training and recruiting of service aware staff. In order to do so, companies need to, firstly, be aware of the difference between selling services and products. This involves being able to deal with the increased number of customers interactions and to collect the customers feedback for future improvements. Secondly, it is important to spread the knowledge gained in the design phase to the sales & service representatives. For example, by documenting instructions during the design phase and then providing this to the frontline personnel (Sayar & Er, 2018).

5.3.1 Be aware of difference between selling services and products

The Sales Director at subsidiary A emphasizes the need for the staff in contact with customers to be able to communicate in the right way, and he most of all points out the need for the salespeople to focus on what is important for the customers. The Head of Service at subsidiary B too emphasizes the need of good communication with the customer, as he means that the service company is guiding the customer in getting the right kind of device. The Software Development Manager means that the BluEye is a beneficial tool for enabling better communication with the customer, as it lets the person at the factory see what the actual problem with the device is when a customer reports a problem:

> *"It is good when you talk to the customer, when the customer wants, and get feedback about the status of the unit and you are: "Okay I try to connect. Okay, I'm online, what has happened?". You try to check the history, and the alarms. Check immediately what has happened. Understand really and you can see how the unit works and you are able to understand what is wrong and what is good."*

The CTO at company B emphasizes that their service is enabling its partner companies, the energy firms, to achieve a closer relation to their customers:

> *"One important part of this is also the value creation in softer aspects. So, the communication between an energy firm and its customers. There are*

many energy firms which are looking for ways to create relations with their customers, to tie them closer to them. And that's something we are working with, trying to create these systems as 'energy services' which the energy firms can use to simply communicate with its customers."

5.3.2 Spread the knowledge gained in the design phase to the sales & service representatives

According to the Customer Service Manager, the Sales Manager at subsidiary A, the Head of Service at subsidiary B and the Business Developer, the knowledge gained in the design phase is spread to sales and service personnel through documentation and training. However, the Head of Service at subsidiary B means that they would like more training and the Business Developer means that they have just started a new initiative for educating the sales and service personnel:

"An initiative that we have started now is to have a knowledge center for cooling. There we will offer education before we launch new products. It can be extra knowledge for technicians, it can be extra sales knowledge."

5.4 Providing Guidance to Customer on System Use

The fifth category in the Sayar & Er (2018) framework is to provide guidance to customers on system use. To do so companies should fulfil three requirements. Firstly, they need to make use of customer's knowledge and experience with the systems, this is important for setting system requirements since they are in contact with the systems every day. Secondly, companies need to help customers interpret the data by e.g. visualizing insights and giving expert guidance. Thirdly, companies need to help customers make good decisions based on the whole system by having dialogues to increase knowledge rather than just giving information (Sayar & Er, 2018).

5.4.1 Make use of customers' knowledge and experience

The Customer Service Manager, the Software Development Manager, and the Business Developer all mention that giving feedback about the systems is not attractive for the customers. According to these representatives, the customers just need the indoor climate to be working as planned. Apart from that they, they are not interested in talking about the systems and being involved in giving improvement suggestions to Swegon. The Customer Service Manager explains:

"Let's imagine, we have a chiller, an air condition unit in summertime. I bought, or I rent my office here, so I'm not the owner of the building. I'm just the owner of this office. I don't care about chillers or heat pumps. It's not my job. I come here because I need an office, that's it. People, when speaking about the building, they forget about the chiller or heat pumps.

They know that during spring it switch from warm to cold and in autumn from cold to warm, that's it."

Furthermore, the Business Development Director claims that it is hard for Swegon to know who their end users are and that it is difficult for the end users to know what products were provided by Swegon. There are several actors involved in the chain from the factory to the end user and also several products involved in producing a good indoor climate. The Technical Manager at subsidiary C explains that the installers do not want them to have close contact with the customers since they might question the quality of the installation. The Business Development Director also explains a difficulty in finding customers that might be able to give them insights:

"No there isn't [incentives for customers to help improve the system] but let's not forget that it is very difficult to identify who is the customer in our business because selling a product where the one who buys is the one that use it. There is a long chain of people and the one that is using the product is different from the one that install the product, is different from the one who bought the product. So, this is quite difficult."

Another source of input for future improvements that the Software Development Manager mentions is the one that BluEye enables. By using BluEye on site, the Research & Development function can almost use it as a prototype. Furthermore, immediate feedback from the units can be used to make changes in the software, as explained by the Software Development Manager:

"For R&D, first of all, because, for example, if you don't have a budget for the prototype, you can send the unit, and monitor for the first month. The first month of the unit's life is very important, to be able to monitor and give immediate feedback on what's happening, analyze the data and maybe release a new software for fixing. It is very important."

Both the CTO at company B and the System Development Director at Swegon means that they have dialogues with the customers to get input for product improvement and requirements. However, company B has a closer relation with its customers, as they often work in joint projects.

5.4.2 Help customers interpret the data

The Head of Services at subsidiary B and the Sales Director at subsidiary A explains that they are using reports to feed information back to customers. The Head of Services at subsidiary B explains that they have a more structured way of doing this while the Sales Director at subsidiary A seems to do it in a more ad hoc way. The Technical Manager at subsidiary C explains that they also want to do this but have not yet started. Furthermore, all of them explain that they use comparisons,

graphical representations and also quantify the insights in savings. The head of service at subsidiary B explains this:

> *"Then we can sort of manage that trend analysis so that we can show the periods of time when they do not need the plant running. So, we can then offer that we put a target in place: "in this period, you're going to save X amount of Pounds in your electrical consumption through the year." So that is a huge value add and again an environmental impact that we can help with."*

The Software Development Manager expresses worry about handling all the data that is produced by BluEye, while also seeing the potential. It was especially hard for them to pick the right variables and the deciding the data quantity needed. Later when the data was collected the they did not know what to do with it. The Technical Manager at subsidiary C also highlights that more knowledge and resources have to be developed. The lack in capability for handling and analyzing data is also confirmed by the Business Development Director, who claims that they lack a structure of how to do and also need more units on the market:

> *"So, you need to have a lot of units in different markets and so on, with BluEye, but what is the most important is that you need a structure behind with people who are recording the data and are analyzing the data."*

Furthermore, the Business Development Director and the Business Developer claims that more can be done using BluEye in terms of services. They both claim that the workflow today is a bit to reactive and lack proactive actions and predictive maintenance. The Business Developer claims that a reason for the lack of services might be that BluEye has been developed as a technology push. Therefore, the sales and service people have been put in a situation where they are supposed to package and sell the opportunities without having all the knowledge behind it. Furthermore, the Business Development Director also claims that a lack of resources or interest may be the reason that not so much of the potential is realized:

> *"You can do thousands of things [with the data from BluEye]. But this is not what at the moment, Swegon, are doing. So, what we can do is, let's say stimulate the fantasy of the sales companies in how they can use this data to create value. But then if they don't have resources, or if they don't have interest, or if they have other priorities, they simply don't do it."*

The Director of R&D at company A describes how their service is collecting data, which they can use to give suggestions for their customers on how they can improve their properties to save more energy. The analysis shows how much money the customer would save on the improvement, which enables company A to sell the service. The System Development Director Swegon claims that they aim to develop

a cloud-based service where they can analyze and present data. This platform will show for example KPIs and overviews of the performance. Furthermore, they want to present predictive actions to the customers. The CTO at company B claims that they provide insights to their customers already today and also use AI and machine learning to provide predictive maintenance. They do it through a web-based interface but also by sending out reports. To make it easier for the customers to grasp the insights they send out predictions, graphs and other visualization tools:

> *"It's time series, so graphs of different kinds that can be seen. Then there are also data in the form of numbers, but most of it. Since there is a vast amount of data, it is difficult to just plot the numbers, so we need some kind of visualization so that people can relate to it."*

5.4.3 Help customer make good decisions based on the whole system

The Head of Service at subsidiary B explains that they offer recommendations to their customers on what alterations to make, for example to increase the temperature to optimize use. Furthermore, they try to educate their customers to understand what is happening in their systems. This enables them to look for trends and patterns but also to make their own improvements:

> *"...we do then educate our customers to be able to interrogate their first-lines so that they can understand what they see, so they can sort of identify areas where they can make self-improvements and get all the benefits from that as well."*

According to the Customer Service Manager, they usually educate customers on how to use the units in a way that is functionally optimal. However, they are not providing guidance on how to best utilize the units in an efficient manner, this is up to the sales companies to do. The Customer Service Manager exemplified a discussion with the customer on functional guidance and underlined that BluEye was used to find the unsuitable behavior:

> *"We are teaching instead the sales company or the sales company directly the end user, about the functionality of the unit because here's a real example. One customer was driving our unit with BMS* [Building Management System]. *He had at the same time the BluEye, but he had a BMS to control the unit. Every time the temperature of the water got to a certain point, he switched of the unit completely. Instead you should not do it. You should keep it running, and when the temperature is dropping you let the compressor start again and so on. He was completely switching off, and then when the temperature in the room, not in the water, was dropping, then he was completely switching on the unit. This was generating problems on the functioning of the unit."*

5.5 Aligning Customer Focus Across the Business

In accordance with the Sayar & Er (2018) framework, companies need to align customer focus across the business. Firstly, they need to be able to bridge product & service perspectives to make sure that things are both demanded and technically feasible. Secondly, by having a corporate system to bring and align all functions to the same standard to make sure all parts of the company handles for example customers the same way (Sayar & Er, 2018).

5.5.1 Ability to bridge product & service perspectives

Both the Software Development Manager and the Head of Service at subsidiary B talks about regular communication and decision making that takes place at the interface between different functions. For example, the Head of Service at subsidiary B explains that they have regular meetings and other communication with factory. Furthermore, the Software Development explains that the Sales Manager, Product Manager, and Research & Development all give their input prior to starting a project formally:

> *"So, it's very important because for the beginning we have input from the product manager and the sales manager, this is the input for the new unit. And this unit goes in officially to the gate, if it is a big project, and is able to give feedback to the R&D department, to have the green light to start the project."*

Apart from that, the software developers and R&D representatives are sometimes on the field to see what is happening and to use their knowledge to find problems and areas of improvements. Furthermore, the System Development Director at Swegon claims that they have an assigned Product Owner that has the responsibility to find out what the customers wants to buy. After that the Product Owner prioritizes what should be made and then communicates with the System Development Director who is responsible for the implementation.

5.5.2 A corporate system to bring and align all functions to the same standard

According to the Business Development Director, Swegon's processes and ways of communicating are ISO certified. Furthermore, they explain that their contact with the subsidiaries works in a specific way. Each subsidiary has one main contact at the factory that is responsible for the regular communication and responsible for resolving issues. However, there are several people at the factories that are in contact with the subsidiaries when it comes to questions about various knowledge areas such as service. The Business Development Director explains:

> *"I am the main contact in the sense that, for the main things but then of course on the daily business there are different points of contact according*

to the different kinds of information that they ask for, if it is product support or an offer for a specific thing or a service or for production or for deliveries and so on. I mean all the different contacts in the different processes for different things. And I am the main responsible for the business."

5.6. Utilizing Methods/Techniques for Systems Thinking and Creativity

The framework provided by Sayar & Er (2018) suggests that companies utilize methods and techniques for systems thinking and creativity. In order to fully do so, they should manage three areas of requirements. Firstly, companies should have an integrative approach to control the systems design process which takes care of both technology and business parts of the offering. Secondly, they should have formalized system methodologies to control the fuzzy front end to understand customer needs. Thirdly, companies should use tools for enabling better idea contribution from various actors or maybe even customers (Sayar & Er, 2018).

5.6.1 Integrated approach to control the systems design process

Both the Business Development Director and the Software Development Manager describes how new input for product development is obtained. The Business Development Director explains how market needs are translated into a business case which is then analyzed through a feasibility study. Then prioritization takes place before the development starts. Meanwhile, the Software Development Manager also emphasizes that the software development is not isolated from the other functions of the firm, and that they all need to be integrated to achieve the best results:

> *"We don't produce software - we make a unit. This is difference between software and application. If you want to know the application, you have to go on the field and get feedback, bring the information here, and improve your software."*

5.6.2 Formalized system methodologies to control the Fuzzy Front End to understand customer needs

The Software Development Manager explains that it is important for the software developers to go on the field to get feedback for future improvements:

> *"We receive a lot of suggestions when the software developers are on the field. Or when the people from R&D are on the site. This happens a lot. Because they bring home a lot of information. A very very impressive quantity of information. [...] This is in my opinion, the only good way testing debugging and releasing, checking on field, give feedback and improve."*

5.6.3 Use tools for enabling idea contribution

The Customer Service Manager explains that they meet with the branch offices twice a year to discuss the products and try to obtain feedback on what should be improved for future products. However, the Business Development Manager explains that there are no concrete incentives for idea contribution, as seen in the quote below:

> *"No, no incentives, the incentives are that they are interested to ask and to pass the information in order to get something better to sell or to use. I mean, they are paid for that."*

Other sources of ideas are the data collected by the products, as explained earlier. The Customer Service Manager and the Software Development Manager explains that this is common for the first products of a new product line, to see if they work as intended in realistic conditions. The Software Development Manager explains it like:

> *"So, it was very important for R&D, to reduce time for the prototype, reduce time to market, and it was very revolutionary technology about how to get data. Because the data from the units, I usually say it's the new oil, this is very important.* [...] *If you don't have a budget for the prototype, you can send the unit, and monitor for the first month. The first month of the unit's life is very important, to be able to monitor and give immediate feedback on what's happening, analyze the data and maybe release a new software for fixing. It is very important."*

When asked about the customers' role in new product development, the Head of Service at subsidiary B means that they try to obtain feedback from their customers (i.e. end users) on what can be improved, both through surveys and workshops. On the other hand, the Technical Manager at subsidiary C means that they have no contact with the end users, because they sell the systems to installation companies which don't want Swegon to have direct contact with the end users.

The respondents working at the factory (the Software Development Manager and the Business Developer) means that the end users are not involved in the product development, since there are no incentives for customers to contribute feedback. In short, the Software Development Manager puts it like:

> *"I would say informed* [about data collection] *but not involved* [in product development]. *Because it is important for us but not for them* [the end users]*."*

6 Discussion

The discussion chapter follows the same structure as the Results and Analysis. In other words, it is structured according to the capabilities framework presented by Sayar & Er (2018) and the subtopics introduced in Table 2.

6.1 Communicating a well-articulated systems design strategy

6.1.1 Form & manage appropriate partnerships

As previously described, the Software Development Manager and the Business Developer both agrees that the Product Manager and the Sales Manager are the ones giving the input for new products. The Business Developer explained that the Product Managers discuss requirements for new products with sales companies. The sales companies function as partner companies of Swegon, meaning that the partners have a say in the development process. This means that partner companies are involved in the design process to some degree, which is aligned with what is recommended by Sayar and Er (2018). It could be argued that the partners have too little say in the design process, as their only involvement is in discussions with the product managers. If that is the case, Swegon could miss out on knowing about operational roles and requirements that are necessary for a successful system design.

Furthermore, the subsidiaries are required to submit reports on quality issues of the products, which are taken care of by the quality department at the cooling factory. This is an example of how responsibilities are shared between the partner companies, as described by Sayar and Er (2018).

In the case of the companies A and B, they both sell their IoT systems to property owners through a partner network of contractors. The contractors all benefit from the IoT as it automates menial tasks for them, and company A and B can leverage their partners' customer networks. Sayar and Er (2018) describe the importance of that the partner companies understand the expected outcome of the IoT system, which can be said to be true in the case of company A and B because of their cooperation with their partners.

6.1.2 Integrated design approach with different departments

The Software Development Manager means that the different stakeholders involved in the design process; being the Product Manager, the Sales Managers, the R&D department, the Thermo Technical Engineers, and the Software Developers. The Product Manager and Sales Manager are giving input for new products, which the R&D department gives feedback on whether it is feasible or not. Later in the process, the Thermo Technical Engineers in cooperation with the Software Developers makes a specification for what is to be developed. Sayar and Er (2018) mean that several stakeholders should be involved as early as possible in the process

to make use of their knowledge and ideas. This could mean that the product development could be improved by involving e.g. thermo technical engineers and software developers earlier in the process, so that the goals and requirements would be even more clear for them.

As stated, Swegon works cross functionally between the software development, the electrical engineering and thermomechanical engineering to understand the possibilities and requirements of the new system. This is, according to Sayar and Er (2018), crucial for achieving a shared understanding of the IoT system.

When the software development team do not agree on what is to be done, the Software Development Manager allows for additional meetings to resolve the issues. Sayar & Er (2018) suggest that the data from the IoT solution should be used in this process, to e.g. show the stakeholders why changes has to be made. The Software Development Manager does not seem to be using data to resolve conflicts today, which could potentially reduce the time needed to get the entire team onboard the same idea.

Swegon is using the first units produced as prototypes for collecting data to see if they are working as intended. This can be seen as another way of using the data gathered by IoT to build synergy between components, as stated by Sayar and Er (2018). However, according to the Business Development Director, product development cannot be based on the BluEye in full scale before more units contains it.

At company A, a product council is responsible for prioritizing what features should be included in future versions of the company's system. The product council is involving and coordinating several different functions of the company, achieving an integrated design approach, as described by Sayar and Er (2018). This allows company A to both get input from several different perspectives of the company and explain to the different stakeholders what the vision and expected outcome of the system is, which according to Sayar and Er (2018) is crucial.

6.1.3 Common understanding of concepts, goals and requirements

The software department at Swegon always visualizes the expected outcome and milestones of a project before they start writing code, to make sure that there is a common understanding of what is to be developed. This could lead to reduced conflicts during the project, as the problem description is clearer (Sayar & Er, 2018). Visualizing the project for the entire department before starting should also help the software department finding possible weak points of it before it is too late, resulting in a better value proposition for the customer.

6.2 Redefining the Roles and Responsibilities of the Frontline Personnel

6.2.1 Change perception of frontline personnel

Front-line personnel play a critical role when delivering an IoT service, and the insights possessed by them is not always recognized by back office representatives (Sayar & Er 2018). At Swegon, there are mixed perceptions about the role of the front-line personnel. As mentioned, the Sales Director at subsidiary A and the Customer Service Manager means that the front-line personnel have more responsibilities than merely servicing the products, namely spreading their knowledge back to the factory for product development and promoting sales. This is corresponding to the suggestions of Sayar and Er (2018), who mean that the front-line personnel are the people in the company with the most product insights and customer contact.

At Swegon, the insights from front-line personnel are transferred back to the factory through the head of the service division of subsidiary B who communicates them to the factory. In contrast, Sayar and Er (2018) describe how the front-line personnel worked together with the back office to re-engineer the product offerings. In other words, Swegon could potentially improve their cooperation between front and back office by working more closely together. However, the front-line personnel are all scattered around Europe while the factory and back office remains in Italy, which complicates the cooperation.

Not all respondents at Swegon agreed that the front-line personnel's insights were important. The Software Development Manager agreed that the front-line personnel theoretically could have valuable insights but argued that they had the wrong focus and characteristics to achieve the full potential of the role. This could be improved in the future as the Business Developer explained that there are coming new initiatives for training the front-line personnel, even though the Software Development Manager claimed that they lacked the enthusiasm which was required but could not be taught.

6.2.2 More customer focused frontline personnel

The Software Development Manager does however see that when developers go on site, they receive valuable input on how the products are working. This shows that the position of the front-line personnel is valuable but that the people there needs the right background and point of view. According to him, the ones in the field needs to know what to look for to be able to see what can be improved. The knowledge and background of the front-line personnel in the case of Sayar and Er (2018) is unclear and could be an important factor to consider.

As mentioned above, Kindström, Kowalkowski, and Alejandro (2015) mean that the front-line personnel's role changes as a manufacturing firm moves towards servitization to be "solver of customer problems and deliverer of brand value". This seems to be the case at Swegon today, at least in the market served by subsidiary B. The Head of Service at subsidiary B explains that he thinks that the front-line personnel needs to have excellent technical knowledge to be able to solve customers' problems, but also that they are the face of the company and need to promote the Swegon brand while interacting with the customer, an opinion that is shared by the Technical Manager at subsidiary C.

The knowledge of BluEye among the front-line personnel varies. The danger of having bad knowledge of the IoT system, according to Sayar and Er (2018) is that the firm then risks having the customers going to a third-party service company instead of the firm. Swegon is currently not doing all service by itself but is utilizing authorized third-party service companies, since they don't have the capacity to serve all customers. It can anyhow be argued that, as the role of the front-line personnel is to solve customer problems, they need good knowledge of the IoT system anyway.

6.2.3 Clearly defined responsibility with partners

As explained above, the responsibilities in service errands is arranged so that the service organization at the factory trains the service personnel at the subsidiaries and assists them in cases when they are unable to solve a customer problem. This is an example of how Swegon actually consolidates the risk of being unable to solve a customer problem, by having the expert organization on stand-by at the factory to assist the subsidiaries when needed. The risk of not being able to do so is, as explained above, losing the customer to a third-party service provider (Sayar & Er, 2018).

6.3 Training and Recruiting Service Aware Staff

6.3.1 Be aware of difference between selling services and products

The need for communicating in the right way with the customers is emphasized by several respondents. Sayar and Er (2018) also explain the need to be able to deal with the customer interface when selling IoT solutions. The respondents at Swegon means that the communication is the most challenging when being conducted with an end user, as they seldom have knowledge or interest in discussing the cooling units. Then it is especially important to be able to deal with the customer interface, to e.g. be able to convince the end user to try possible quick fixes to avoid having to send service personnel to the plant. This is in contrast to the point being made by Wünderlich et. al. (2013), who mean involving the customer in maintenance has a positive effect on the customers attitude to IoT services. Furthermore, the Software Development Manager claims that BluEye can even enhance communication with

the customers, as it enables the service personnel to understand technical issues without the customer explaining them.

The IoT solution at company B also enables the customers of company B to communicate better with their customers. In this case, the customers of company B is both energy producers and energy consumers. This way, company B is working as an interface for the energy producers towards their customers, the energy consumers. This enables the energy producers to enhance their relationship with their customers and move towards selling a service instead of just energy.

6.3.2 Spread the knowledge gained in the design phase to the sales & service reps

Several respondents at Swegon explained how the sales and service personnel are trained, mainly by the Customer Service department at Swegon. The same department also prepares documentation which standardizes the knowledge of the sales and service personnel. Sayar and Er (2018) recommends firms to document the knowledge already in the design phase, which could make the documentation at Swegon more effective. It also seems like there currently is a need for more training of the sales and service personnel at Swegon, which indicates that the training needs to be enhanced.

6.4 Providing guidance to customers on system use

6.4.1 Make use of customers' knowledge and experience

As mentioned, several representatives at Swegon claim that there are very few interactions with the customer for receiving feedback, mainly since the users lack interest. According to Sayar & Er (2018), it is important to involve customers in the design process in order to get a better picture of the requirements that will be set for the systems. The authors mention that IoT systems are more interactive and changing in a more rapid way, therefore an increased customer interaction is important. In other words, the behavior of Swegon is contradictory in comparison with the literature.

Another reason for the lack of customer interaction provided by the Swegon representatives was the difficulty in identifying the end users since there are several actors involved in the value chain. Furthermore, they also claim that it is hard for the end users to know what products are supplied by Swegon. However, the interviewee at Swegon Corporate and especially at company B both show signs of discussions and inputs from their own customers. Since these actors provide similar offerings in the same industry, it seems possible for Swegon to do the same. However, it is possible to argue that there is less interaction with cooling systems than with IoT systems in general, and therefore the use of customer insights is not as critical as Sayar & Er (2018) claim. Another issue that was mentioned by the

Technical Manager at subsidiary C was that the installers did not want them to talk to the end users.

Instead of relying on customer insights, Swegon relies more heavily on data from BluEye gathered from the first units of a new product version as input for Research & Development. The Swegon interviewee claims that this is extra important in the beginning of a product launch since immediate feedback can be gathered. This is not arguing against Sayar & Er's claim that customer knowledge is extra important, but it rather adds to it.

6.4.2 Help customers interpret the data

Subsidiaries A and B are currently feeding their customers with insights from the BluEye data. As mentioned, they present quantifications, comparisons and graphs to visualize, something that subsidiary C is looking to do in the future. According to Valencia et al. (2015) it is preferred to use visual aids in order to make the message easily graspable by the customers. So, subsidiaries A and B should keep doing this even more and subsidiary C should follow their proposed plan.

However, the Software Development Manager expresses difficulty and anxiousness towards handling the big amount of data they are encountered. Capabilities that the Business Development Director and the Technical Manager at subsidiary C also witness is lacking. Sayar & Er (2018), claim that guidance from experts is important for customers to understand the potential of their system and also to be able to grasp insights from it. If the Swegon representatives are unable to handle the data themselves, there will be no expert advices to pass on to the customers. Therefore, it is important that they acquire the necessary capabilities for handling the vast amounts of data that will be gathered in the future.

In contrast to Swegon, company B are equipped with machine learning and AI knowledge which they use for providing visualized insights in a web-based interface. This indicates that they have handled one of the challenges for IoT implementation presented by Lee and Lee (2015), which is utilizing new tools methods to analyze the data. Swegon are also looking to develop a platform for showing their customers KPIs but also to provide predictive maintenance. Company A gives suggestions to their customers on how to save energy which they then use at sales arguments for selling services to their customers. Sayar & Er (2018), claim that selling services, and not just the product is important when offering IoT systems. The Business Development Director and the Business Developer agrees that more services should be offered, especially with a proactive focus, like predictive maintenance. The former representative claim that the reason for a limited range of service offerings connected to BluEye mainly depends on the sales companies' interest and maybe lack of resources.

As the Business Developer explained, BluEye is a case of technology push, where the customers are not specifically asking for the improvement of the product. As Li et. al. (2012) explain, different industrial driving forces and strategic intents calls for different sets of capabilities. In the case of Swegon, the firm seems to be in a situation of get-ahead strategy in technology, which requires the firm to be able differentiate and further develop the existing technology to achieve competitive advantage (Li et al., 2012). Furthermore, company B, which is in the same situation as Swegon, has differentiated and further developed the existing technology in terms of data analytics in successful way. Therefore, this indicates that the strategic intent and industrial driving force are important factors to consider when assessing capabilities for IoT implementation.

6.4.3 Help customers make good decisions based on the whole system

The Head of Service at subsidiary B, apart from giving recommendations, explains that their branch tries to educate the customers to be able to understand their systems and to take actions. This is also partly done by the customer service department; however, their education scope is limited to functional use and does not include efficient use. According to Sayar & Er (2018) it is important to teach the system users how to use the systems by enhancing their skills and not just providing information. The behavior of subsidiary B seems to be in line with the literature in the sense that they are educating the users and not just providing recommendations. The same goes with the customer service department, while their scope of education can definitely be expanded to also enhance customer skills on efficient use.

6.5 Aligning customer focus across the business

6.5.1 Ability to bridge product & service perspectives

Subsidiary B and the software department are both involved in regular discussions with other functions to share information and to take decisions. Furthermore, the software developers and R&D representatives are sometimes on the field to get new insights. Sayar & Er (2018) show that having recurrent interactions between different functions at the firm to take decisions gives a positive effect on the designed IoT systems. Furthermore, the authors highlight the importance of combining service and product perspectives. The Swegon behavior presented is aligned with this and should be encouraged at other departments as well. The behavior is also shown at Swegon where the Systems Development Manager explains that he interacts with the product manager to align market needs with what is possible to implement.

6.5.2 A corporate system to bring and align all functions to the same standard

As mentioned, Swegon processes and ways of communicating are standardized. Furthermore, the factory's contact with the subsidiaries is organized in the way that each subsidiary has a main contact at the factory. Sayar & Er (2018), show that having all parts of the company following the same types of procedures is beneficial for the success of IoT system design. In a way, this is what Swegon showcase in the provided examples with ISO certified processes and having main contacts for all subsidiaries. However, few other cases were brought up or discussed by the respondents in the interviews.

6.6 Utilizing Methods/Techniques for Systems Thinking and Creativity

6.6.1 Integrated approach to control the systems design process

In the development process at Swegon, the business and technology parts are integrated early in the process. The Software Development Manager also explains how they cannot isolate the software from the rest of the unit, that they need to consider all parts. This is aligned with the recommendation of Sayar and Er (2018) to look at the IoT system as a whole, not separate parts. This could potentially mean that the different functions within the company enable synergy effects between the different components of the systems.

6.6.2 Formalized system methodologies to control the Fuzzy Front end to understand customer needs

One way for the software developers at Swegon to understand customer needs is to go on site and see how the products are working in practice. This does however seem like an informal method, unlike the recommendation of Sayar and Er (2018) to formalize the process. This means that the developers do not go on site for each case, which could lead to suboptimal insights for development. The reason for this could be that spending time on sending the developers to customer sites is deemed to not be valuable enough, as it requires both coordination and travelling to be realized. However, if the insights from the front-line personnel is improved, as mentioned earlier, the same information could be obtained from the customer sites without needing to send the software developers there.

6.6.3 Use tools for enabling idea contribution

As mentioned above, the Customer Service Manager meets regularly with the branch offices to discuss further improvements of the products. This can be viewed as a tool for enabling idea contribution from the personnel in the branch offices as Sayar and Er (2018) describe. However, it can also be argued that meeting twice a year is too seldom to ensure ideas are captured, as the staff might forget ideas if

they get them some time before the meeting. The tool described by Sayar and Er (2018), the innovation portal, on the other hand, lets the staff contribute with ideas on their own terms, which could possibly lead to more ideas being obtained.

It is also common for Swegon to collect data from the first units of a new product version. This is because the testing facilities at the factory are not enough to test the units in all possible conditions and over time. However, the respondents at the factory argue that data collection is better than other communication with the end users, as the end users lack the interest and knowledge to suggest improvements. While Sayar and Er (2018) emphasize the importance of data analytics, they also argue that qualitative data from the customers are an important complement, as all aspects of a product can't be visible in data.

There is a discrepancy in the degree of communication with end users between subsidiary B and C. While subsidiary B surveys its end users for feedback and sometimes even has workshops with them, which works as tools for idea contribution (Sayar & Er, 2018), subsidiary C barely has any contact at all with them. As mentioned previously, BluEye is more commonly sold in the market served by subsidiary B than in the market served by subsidiary C. As BluEye works as a direct link between Swegon and the end user, it could be the reason for the subsidiary B's closer customer cooperation.

7 Conclusion

The research question for the thesis was *Is the Sayar & Er (2018) framework, for capabilities for successful IoT systems design, applicable and beneficial in the indoor climate industry?* To answer the research question, each category from Sayar and Er's framework was analyzed. For the parameter "Communicating a well-articulated systems design strategy", it was found the framework is beneficial and applicable, since the partners are the ones using the IoT system, which means that the firm needs to have a clear understanding of what functionality to include. It was also found that the development processes in the cases seems similar to the ones in the study of Sayar and Er, which is why their framework seems applicable.

For "Redefining the roles and responsibilities of the front-line personnel", it was found that it could be the case that the framework is not applicable for two reasons. Firstly, it was argued that the front-line personnel, even with training, will not possess the right mindset to be able to suggest valuable improvements for the back-office. That could, however, also be a sign of the respondents in the back office having the wrong perception of the front-line personnel. Secondly, the customers are scattered geographically, which requires the service organization to be so too. This means that it requires a lot of coordination and planning if the front-line personnel are to be involved in re-engineering and re-assessing of product offering. Also, Sayar and Er argues that the front-line personnel need extensive knowledge in the IoT system to be proper solvers of customers' problems. However, we argue that in this case, the traditional knowledge of the front-line personnel in thermo-technical engineering is more important, as the IoT tool is not very complex to use.

In the "Training and recruiting of service aware staff", it was found that the framework is applicable and beneficial. The communication with customers is found to be of great importance when delivering services in this industry, and furthermore IoT enhances that communication.

When it comes to "Providing guidance to customers on system use", Sayar and Er means that IoT makes the product more interactive with the customer. In this case, it depends on who the customer or end user is. For industrial end users, the data is very important, and they are interested in knowing and optimizing. For those customers, it is also important to provide education on how to best use the systems, as proposed by the framework. For non-industrial end users however, the indoor climate is a hygiene factor and is supposed to work without complications, and they are not interested in how it works. This means that this category in the framework is applicable for some customers, and not for others.

For "Aligning customer focus across the business", it was found that it is important to have cross functional interactions and decision making in some parts of the

company which is aligned with the framework. Having standardized approach when it comes to work processes and communication seems equally important in the indoor climate industry as in the presented framework.

In "Utilizing methods/techniques for systems thinking and creativity", it was found that to be able to bridge technological feasibility with the business perspective seems to have the same implication in the examined industry as in the study by Sayar and Er. It was also found that on the one hand, having a formalized procedure for collecting insights about market needs is even more important in the indoor climate industry since few end users are willing to provide feedback. On the other hand, an IoT solution in itself helps providing insights to customer behavior. Furthermore, partner and coworker insights also require formal ways of collecting experience. Lastly, as previously mentioned, the end users are less active in this industry as they typically do not care about how the cooling units work. Sayar and Er suggests that firms should collect qualitative data from the end users, but the low interest from them in this case hardens that. That is why data collected by the units plays a bigger part in this case.

In addition to the capabilities suggested by Sayar and Er, we argue that the firm should consider the industrial driving force and strategic intent of the technological development as suggested by Li et. al (2012), based on the findings from company B. This enables the firm to better streamline its approach to development to the strategic requirements of the scenario it is facing.

7.1 Managerial implications

In summary, the original framework by Sayar & Er is in most cases applicable also in the indoor climate industry. However, three explicit alterations have been made to create a better fit. Firstly, "Redefined roles and responsibilities of the front-line personnel" is not as important, while clearly defined responsibilities with partners is still needed. Therefore, in the proposed framework shown in Table 5, "Redefined roles and responsibilities of the front-line personnel" is removed and replaced with "Clearly defined responsibilities with partners". Secondly, guidance on system use should still be given to customers. However, this is not applicable for all customers but rather the industrial ones, which are typically more involved in the operations and uptime of the system. Lastly, the insights provided by Li et al. (2012) concerning industrial driving force and strategic intent for the IoT implementation should be considered.

Table 5: Altered framework for the indoor climate industry based on Sayar & Er (2018) and Li et al., (2012)

Communicating a well-articulated system design strategy
• Form and manage appropriate partnerships • Integrated design approach with different departments

• A shared understanding of concepts, goals, and requirements within project teams
Clearly defined responsibilities with partners • Clarify who does what in the value chain
Training and Recruiting Service Aware Staff • Be aware of difference between selling services and products • Spread the knowledge gained in the design phase to the sales & service reps
Providing Guidance to Industrial Customers on System Use • Make use of customers' knowledge and experience • Help customers interpret the data • Help customers make good decisions based on the whole system
Aligning Customer Focus Across the Business • Ability to bridge product & service perspectives • A corporate system to bring and align all functions to the same standard
Utilizing Methods/Techniques for Systems Thinking and Creativity • Integrated approach to control the systems design process • Formalized system methodologies to control the Fuzzy Front end to understand customer needs • Use tools for enabling idea contribution
Be aware of the industrial driving force and strategic intent for IoT implementation • Calls for different sets of capabilities

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Appendix

Appendix A: Interview template for complementary cases

Background

- Vad gör företag x?
- Vad jobbar du med på företag x?
- Hur länge har du jobbat med det?
- Vilka är era kunder och varför väljer de er?
- Skulle du säga att ni säljer en produkt eller en tjänst?
- Med IoT menar vi produkter som kan samla in data via sensorer och även är kopplade till internet för att kunna läsa av datan på distans. Har era produkter alltid använt IoT?

Systems development

- Hur jobbar ni med nya produktlanseringar?
- Kan ni förbättra produkten genom mjukvaruuppdateringar?
- Hur ofta släpper ni mjukvaruuppdateringar?
- Hur vet ni vad ni ska ändra i produkten?

Data

- Vilken data samlar ni in?
    - Vet ni hur kunderna använder den?
- Vad använder ni datan till?
- Hur presenterar ni datan för kunden?

Affärsmodell / Värdekedja

- Hur används datan ni samlar in i affärsmodellen?
- Vad har ni för affärsmodell, (har den förändrats)?
    - Vad är ert värdeerbjudande till kunden?
    - Vilka är era kunder?
    - Hur tar ni betalt (abonnemang, time and material, upptid)
- Beskriv er värdekedja? T.ex. kunder, kunders kunder, end users, förhållanden, kommunikation

System

- Vilka typer av produkter/system kan kopplas samman med ert system?
- Vilket värdeskapande möjliggör detta enligt dig?
- Vilka system kan ert system kommunicera med?

Avslutning

- Vill du lägga till något om värdeskapandet som du tycker att vi har missat?
- Vet du någon annan på företaget som vi borde prata om detta med?

Appendix B: Interview template for Swegon

Background

- What are you working with at Swegon?
- For how long have you been working there?
- How would you describe Swegon as a company?
- What is BluEye? What do you think about it? What is the purpose of it? What are the opportunities?
- What does the concept IoT mean to you? What role will it play for the company's future?

Design process of products and its integrated services

- Describe the design process? What activities do you have in house? What do you design, soft/hardware? Please draw on this paper.
- Which stakeholders are involved in the design process of the system? When are they involved? Why? How? Please draw on this paper.
    - How is it decided who participates?
    - Who decides?
    - How much do you work (closely) together?
    - Information or collaboration?
- How would you go about if there are difficulties in convincing stakeholders (e.g. engineers) that changes needs to be made in the design process?
- What was/are the goals and requirements of the design of the product and it's integrated services? How are they formulated? Who knows about them? How do you make sure everyone are at the same page?
- How often do you release new updates/offerings? How often do you update products?
    - How do you know what to change in the product?

After sales service

- What is the role of after sales service personnel (field representatives) in the company?
- Do they have other responsibilities apart from after sales service?
- *After sale:* How long would you say the response time for you is: from becoming aware of a problem, until you are onsite and can fix it?
- What do field representatives know about BluEye?

Competence

- What are the most important characteristics of front line personnel? Are there any employee characteristics that aren't present today which you think will be needed in the future? Why/why not?

- How do you make sure that the competence of your service personnel is up to date?
- How do you document knowledge obtained in projects to create value for the company as a whole?

Data analytics

- What data do you collect and how? How do you interpret it?
- In which activities is the data insights useful?
- How do you gather feedback on future product development?
    - Are customers involved?
    - Are there any incentives to provide suggestions for people not directly involved in product development (e.g. customers)?
- How do make sure that the customers understand the data insights?
- How involved are you in the customers' operations? What interactions do you have? What do you know about their operations?

Techniques for design thinking

- How do you develop new ideas for product development?
- What is the product development process like?

Wrapping up

- Is there anything that you think is interesting for us to know that we have not brought up?
- Do you have any other contact that you think we should interview on this topic?