

Organizational Change in Digital Servitization

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Preface

This thesis aims to explore how organizations change when utilising digital technologies as they move from being product-oriented to become more service-oriented, often referred to as digital servitization. It has been written as the final part of the Master Program in Industrial Engineering and Technology Management (IndØk) at the University of Agder.

The project was formulated and undertaken at my own choosing to improve the chances of maintaining a high degree of interest throughout the project, as well as aiming for something that seemed relevant in today's economy. The research was experienced as difficult due to its content being complex and completely new to my eyes, but as a result of this – its relevance was proven countless times when researching which kept my motivation and interest up, therefore making the project highly educational.

I would like to thank my supervisor Tor Helge Aas for his much appreciated workshops and excellent guidance and support during this process. By expressing his interest in my thesis, it was experienced as easier and more rewarding to write. I also wish to thank all of the respondents in the multiple case-study. Without their cooperation I would not have been able to conduct this research.

Finally, my thanks to family and friends who helped me gain audience with some of these respondents as well as helping me with other aspects of this project. And a final appreciation for the same people who supported and guided me along this exiting journey of an education.

I hope you enjoy reading it as much as I enjoyed writing it.

"Sharing is good, and with digital technologies, sharing is easy." – Richard Stallman

Grimstad, 15.06.2018

yoran Salud

Gøran Sæland



Abstract

Recent changes in markets where customers are demanding more customisation, flexibility, freedom of choice, and instant response; manufacturers and other organizations seek to become more service-oriented and customer-centric for the purpose of recognising and realising product-service offerings, which will enable them to meet the needs of customers with greater capabilities. The process of becoming more service-oriented and customer-centric have been termed servitization, where recent advancements in digital technologies and the rise of Internetof-Things have lead researchers to acknowledge the importance of embedding technology in product-service systems. This acknowledgement has brought the concept of digital servitization to life where more emphasis on digital technology is present. Digital servitization was first introduced in 2015 and has therefore just recently gained the attention of researchers; where the process of digital servitization, what digital technologies utilised in this regard, and how they are utilised, are yet to be explored.

This study seeks to explore how organizations change when implementing a digital servitization strategy, and what digital technologies could be deployed to aid this process and enhance future product-service offerings. The following research is based on an abductive approach which implies that both deductive and inductive approaches are utilised, with more emphasis on the latter. It has been conducted with the qualitative method of multiple case-study where five manufacturers and two IT consultant agencies were interviewed.

My findings indicate that these companies are increasing their focus on leveraging data. They seek to establish more sources for gathering data both internally and externally by emphasising a digital ecosystem; and engage in collaborative partnerships with other players in this ecosystem to accomplish greater capabilities in the leverage of data. A culture of sharing and receiving data will have to be mutual for all collaborators. Processes are to be as efficient as possible for allowing data to be transmitted and managed in real-time, where a strong digital infrastructure must be present for this to be possible. By establishing a single digital system, or platform which will consist of all the data, could allow for more complex digital services to be identified and developed; where digital technologies such as blockchains, digital twins, EHF, AI, IoT, AR, and VR are elements that could improve their capability in recognising and realising these services. The importance of a new way of thinking are highlighted due to opportunities in digital technologies being limited only by imagination. The findings in this study could help organizations to better implement a digital servitization strategy.



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1 Introduction

Competition in industrial sectors have increased dramatically partly due to the emerging economies in Asia and the Middle East (Huxtable & Schaefer, 2016). Manufacturers in the West are shifting their focus over to customers to offer more customer specific offerings (Porter & Ketels, 2003). This requires the manufacturer to move away from traditional practises and become a provider of solutions, or *product-service systems* (Oliva & Kallenberg, 2003), which inhibits the solution provider to "offer 'bundles' consisting of customer-focused goods, service, support, self-service, and knowledge, where service would dominate the era" (Vandermerwe & Rada, 1988, p. 316). This shift has been termed the servitization of manufacturing (Baines, Lightfoot, Benedetinni, & Kay, 2009), and is perceived as a difficult process due to challenges being known to occur in the organizational dimensions of culture (Baines et al., 2009), human resources (Dubruc, Peillon, & Farah, 2014), processes and capabilities (Martinez, Bastl, Kingston, & Evans, 2010), strategy and strategic alignment (Rabetino, Kohtamäki, & Gebauer, 2017), and network (Kindström, 2010); in addition to some financial difficulties (Neely, 2007).

The growing competition may also be a result of the ongoing *digitalisation* wave and the continuous advancements in digital technologies, where volatile markets inhibit the need for better response; forcing organizations to optimise performances and capabilities by changing the way people work (Henriette, Feki, & Boughzala, 2015). Elements of *information technology* (IT) and *information communication technology* (ICT) have become more reliable and powerful; less costly, sized, and power consuming; and will continue to do so if we are to take Moore's law into consideration (Moore, 1998; Yoo, Henfridsson, & Lyytinen, 2010).

With the three industrial revolutions of the past, some researchers believe that the coming advancements of *Internet-of-Things* (IoT) in integrated product-service systems will alter society and business as we know it, and give birth to a new revolution – *Industry 4.0* (Parviainen, Tihinen, Kääriäinen, & Teppola, 2017). The embedding of digital technologies in products and services will increase their complexity, inevitably altering their design, production, distribution, and use; resulting in the complexity, abstraction, and problem-solving skills required by employees to increase as well (Lerch & Gotsch, 2015a).

Technologies of IoT allows smart houses and smart factories to see the dawn of day and will bring disruptive changes to countless industries. This will require manufacturers and other industries to alternate and emphasise the leverage of data to allow for digital technologies to be implemented in new ways. Within digitalisation, even though its importance is widely



recognised, some researchers state that traditional companies have trouble grasping the impacts and potential benefits of a digital transformation, and struggle to understand data can be utilised (Parviainen et al., 2017). The strengths of digital technologies does not lie in the technology itself, but rather on how companies integrate them to exploit its benefits (Kane, Palmer, Philips, Kiron, & Buckley, 2015). According to Kane et al. (2015), the overlying challenges lies within strategy, culture, and leadership to drive the transformation through a clear digital strategy, and also notes a lack of research regarding how to manage digital transformation projects.

Research on the two concepts of servitization and digitalisation have been developed in isolation, where their possible interaction has only recently been recognised (Paschou, Adrodegari, Perona, & Saccani, 2017). This may have been triggered by the higher need for customisation and efficiency in providing services on a global scale (Cenamor, Rönnberg Sjödin, & Parida, 2017). The increasing interest in digital technologies' role in product-service systems have set the path for *digital servitization* to flourish, where digital servitization is formally described as "the provision of digital services embedded in physical products" (Vendrell-Herrero et al., 2017, p. 69). Several researcher acknowledge this interaction to be a unexplored subject in the academia, and despite the general agreement that utilising digital technologies could improve and accelerate the servitization process, reshape industries, and enable novel product-service offerings, little attention has been set to understand how this can be achieved. (Coreynen, Matthyssens, & Van Bockhaven, 2017; Grubic, 2014; Lerch & Gotsch, 2015a; Paschou et al., 2017; Vendrell-Herrero et al., 2017).

A search on "digital servitization" in Google Scholar will provide forty-one results (09.06.2018) where the first article was published in 2015 and the majority in 2017 and 2018. Just recently, Bustinza, Gomes, Vendrell-Herrero, and Tarba (2018) published their article "An organizational change framework for digital servitization: Evidence from the Veneto region" which would arguably be a way of proving this thesis' relevance. Also, while exploring my options for future jobs, organizations seem to be requesting more competence in Business Analytics (BA) and Business Intelligence (BI) which in combination will explore and analyse data in the organization to better understand how the business is doing, how to make better informed decisions that improve performance, and create new strategic opportunities for growth (Roth, 2017).

We live in the information era, also known as the computer age or data age, which is characterised by a shift from industrial production to production based on information and digital technologies. Firms have attained a higher focus on data as this could provide



information to help reduce the costs of production and increase its efficiency (Birkinshaw, 2015). With more data being generated, trouble arises concerning security and the reliability of its content. In May 2018, the European Union Parliament launched the new General Data Protection Regulation (GDPR) directive to empower EU citizen's data privacy and reshape the way organizations manage data (European Commission, 2018). This could be seen as a direct consequence of what Cambridge Analytica did by collecting information from millions of Facebook profiles for the purpose of targeted political advertisement in favour for Donald Trump's presidential campaign. In an interview conducted by Business Insider with Giovanni Buttarelli who is responsible for helping enforce data protection laws across the EU, Buttarelli stated that "it was not by chance, it was not a data leak, it was not a breach of contract, but actually the result of a standard and later on a predominant business model" (Kanter, 2018).

With the coming advancements in wireless connectivity and other elements of ICT, the fourth industrial revolution with the utilisation of IoT technologies is on the rise. Disruptive changes are yet to come for industries in every sector across the world, where establishing strong digital infrastructures, securing data, and implementing digitalisation initiatives are required to facilitate the coming change. Present businesses will become obsolete, but new ones will arise; market segments will disappear, but new ones will appear; competence and experience in different professions will be less required, but new ones will increase in demand. Alterations in manufacturing and other industries will come either they want it or not and should therefore evolve in parallel rather than following the footsteps of others.

As mentioned earlier, many researchers suggest that servitization will imply alterations in business' culture, human resources, structure, network, processes, and capabilities; where digitalisation on the other hand will entail challenges in culture, strategy, and leadership. Due to the recent convergence of these two concepts, the term of digital servitization have emerged which is perceived as being an yet unexplored subject. This study seeks therefore to explore the same alterations and challenges but in the context of digital servitization. With my background as a computer engineer, it would be interesting to investigate how organizations are changing while utilising digital technologies in the process of becoming servitized, and how the issues of digital security could be managed. As there exists less research on what types of technologies are used, how they could be used, and digital servitization in general, this research could be perceived as explorative. To limit the study in an attempt to tighten the scope of this research, the "how" is excluded which leads to the research question to be formulated as follows.



What organizational changes occur when firms utilise digital technologies to move from being product-oriented to become more service-oriented, and which digital technologies could be used in this regard?

The following content of this thesis is structured in the following way: Chapter 2 is concerning the literature review which functions as a foundation for the research. Chapter 3 describes the research method used in this study as well as a minor description of the selected case companies and informants. Chapter 4 presents the findings from analysing the empirical data derived from the interviews. These findings will be discussed in chapter 5 in light of prior research and the proposed research question where propositions will be concluded in each subchapter to add knowledge to the field of digital servitization. Theoretical contributions, practical implications, and limitations of the study with suggestions to further research question.



2 Literature Background

As a starting point, literature reviews on servitization and digitalisation were separately researched to identify primary authors and key terms surrounding the concepts, additionally looking over reoccurring references. This resulted in an overview of where and how to focus the next round of research; after gaining more knowledge in both concepts, the focus was aimed to their intersection and how they could potentially work together.

Google Scholar and Oria, including the UoA library, were of the main sources to gather information on the topics and build a foundation for the research. As mentioned, servitization and digitalisation were the initiating point where keywords such as *servitization*, *servitication*, servitisation, product-service systems, service, complex services, PSS, service-orientation, service-oriented and literature review were used to explore servitization. And digitalisation, digitalization, digitalising, digitalizing, digitalised, digitalized, digitising, digitizing, digital transformation and literature review where used for the other. Next, these keywords were combined with words such as manufacturing, business model, strategy, solution provider, transformation, organisational, organizational, change, culture, human resources, structure, network, processes, capabilities and data. These searches where then coupled to explore their potential connection, and further supplemented with IT, ICT, IS, AI, AR, big data, cloud computing, and digital infrastructure. IoT, dynamic capabilities, and Industry 4.0 was revealed as relevant where these keywords also got coupled with the subjects mentioned above. Every search had an overlaying focus on servitization as this was the intended field of research.

Close to three hundred articles were downloaded, where almost one hundred of them were deemed relevant and inserted to the Mendeley citation tool. The feature of "related articles" was utilised within Mendeley and Google Scholar for the most interesting and relevant articles which gave me access to articles not previously detected. The authors who were involved in more than one article within the subject of servitization were Tim Baines, Ornella Benedetinni, Saraa Brax, Elgar Fleisch, Thomas Friedli, Heiko Gebauer, Daniel Kindstöm, Christian Kowalkowksi, Howard Lightfoot, Andy Neely, Rogelio Oliva, Glenn Parry, Palie Smart, and Arnold Tukker. Within digital transformation with emphasis on services, the common authors were Matthias Gotsch, James E. Heppelmann, Hung An Kao, Jay Lee, Christian Lerch, Andrew McAfree, Michael E. Porter, Nicola Saccani, David J. Teece, Ferran Vendrell-Herrero, and Youngjin Yoo. However, some of these authors are not referenced in this thesis because their work was only used to improve knowledge of the subjects at hand.



2.1 Servitization

The term *servitization* was first introduced by Vandermerwe and Rada (1988) as "*the increased* offering of fuller market packages or 'bundles' of customer-focussed combinations of goods, services, support, self-service and knowledge" (p. 314), and is widely known as the process of adding value by adding services to products (Baines et al., 2009). To understand the concept better, the case of Rolls-Royce's TotalCare Solution – power-by-the-hour is often mentioned in the literature. Rolls-Royce Aerospace no longer sells aero engines. The customers will instead buy the capability the engines delivers, and the responsibility for risk and maintenance remains with Rolls-Royce, thus generating revenues by making the engines available for use (Neely, 2007). As of 2016, the company of Rolls-Royce had an underlying revenue of £13,822 million in total where 49.2% came from services (Rolls Royce, 2017). The goal of becoming servitized have in some cases been noticed as to attaining a 50:50 ratio in revenue from products and services (Huxtable & Schaefer, 2016). The Roll-Royce case is therefore not only highlighted as a way of grasping the concept but is often seen as one of the main success stories of servitization (Baines, Lightfoot, Smart, & Fletcher, 2013).

The research field surrounding servitization have since the late 1980s increased rapidly, and some key authors have presented similar definitions but with minor variations (Baines et al., 2009). Andy Neely's (2009, p. 107) definition seems to be more commonly accepted in the academia where he define it in the following way: *"Servitization involves the innovation of an organisation's capabilities and processes so that it can better create mutual value through a shift from selling product to selling Product–Service Systems"*. This definition is close to identical to the one presented by Baines et al. (2009), which is a result of a literature review intended to collect and combine research on servitization in an attempt to generalise the concept.

2.1.1 The Evolution of Servitization in Practice and Research

Vandermerwe and Rada (1988) describes how the term servitization probably emerged through three overlapping stages. Initially, companies considered themselves to be in the fields of goods or services. Because of an uprising in technology and other converging trends, conventional views were no longer sufficient. This lead to the second stage where most companies began to understand that they would have to provide both goods and services to stay competitive. Finally, the firms would move over to "offer 'bundles' consisting of customer-focused combinations of goods, services, support, self-service, and knowledge" (p. 316) where service would dominate

the era (Vandermerwe & Rada, 1988). This movement was termed as the servitization of manufacturing (Baines et al., 2009).

In an article by Lightfoot et al. (2013), the authors point out that the existing literature on servitization is complex and diversified. By reviewing other research papers from different research communities that collectively represent a body of knowledge about the servitization of manufacturing, five principal communities were identified. The communities are Services Marketing, Service Management, Operations Management, Product-Service Systems and Service Science Management and Engineering.

Over a time span of fifty years from 1960 to 2010, Lightfoot et al. (2013) identified when, and from which community articles on servitization were published. Their findings show that the process of servitizing has been mentioned under different terms before Vandermerwe and Rada first entered the field in 1988 and stretches as far back as the late 1960s in the fields of Services Marketing (1960-1970), Service Management (1970-1980) and Operations Management (1980-1990). The most notable finding on the other hand, is how all five communities have since the year of 2000 and up to 2010 published three to four times more than what they did in the 1990s (Lightfoot et al., 2013).

2.1.2 Why are Organizations Servitizing?

In recent years, competition in industrial sectors have dramatically increased partly due to the growth of emerging economies in Asia and the Middle East (Huxtable & Schaefer, 2016; Turunen & Finne, 2014). To cope with this challenge, several manufacturers in the West are shifting their focus to customers in pursuit of co-creating products and services that meet customers' needs, thus avoiding competing on the sole basis of cost (Porter & Ketels, 2003; Turunen & Finne, 2014).

Baines et al. (2009) have in their literature review concluded that within the research field of servitization; financial-, strategic-, and marketing opportunities are commonly suggested to be the three major drivers for firms to servitize. The three drivers are further articulated by Baines et al. (2009) which is summarised and presented below.

In terms of financial opportunities, higher profit margins and more stable income are highlighted. It is estimated that, in some sectors, revenue from service can potentially be double or triple the value of new product sale. Services are also reckoned to be more resistant to economical fluctuations. Strategic opportunities are mainly concerned with gaining competitive advantage. The use of service elements can help differentiate the offering and set barriers for



competitors due to integrated product-services being less transparent and more labour dependent, thus making the total offering more sustainable and harder to imitate. Marketing opportunities are generally understood as selling more products using services. The service component in marketing is known to influence the purchasing decision by assessing its importance. This is especially true in business-to-business (B2B) markets where customers are increasingly demanding more services to achieve higher flexibility and technological complexity, and to focus more on their core competence. Services also tend to increase customer loyalty, induce repeat-sales, and most importantly to give the service provider insight into the customers business' and needs to offer other products or services as well as being enabled to develop more customised solutions.

2.1.3 Challenges in Moving into Service

The process of servitization can be considered as an reinvention of the firm, or organizational innovation, which requires a shift from product-orientation to service-orientation (Dubruc et al., 2014). This shift is not a simple process and does not guarantee a positive outcome, where a negative outcome is often due to poor implementation (Rabetino et al., 2017). According to Baines et al. (2009), the adoption of a servitization strategy brings numerous challenges both internally and externally.

Within the literature, some of the major challenges are identified to regard around several different dimensions of a firm though many are reciprocal to one another, meaning that a given challenge may be relevant in more than one dimension. Challenges are known to occur in the organizational dimensions of culture (Baines et al., 2009), human resources (Dubruc et al., 2014), processes and capabilities (Martinez et al., 2010), strategy and strategic alignment (Rabetino et al., 2017), and network (Kindström, 2010).

When Neely (2007) investigated the global trends of servitization of manufacturing firms, he found evident proof that the larger organizations in terms of number of employers where the ones that seem to be more successful in servitizing. Though he did not conclude this as a fact, his analysis show that the larger and more resourceful organizations could be better equipped to successfully implement a servitization strategy.

Cenamor et al. (2017) stresses the importance of having the front-end and back-end units of the organization be connected for service offerings to be perfected. They argue that a flow of information between these two will be required to gain collaboration and a greater



understanding of their products and services. A way of bridging these units would enable the firm to achieve an efficient and flexible coordination of the activities of these two.

In addition to the areas mentioned above, many firms experience financial challenges while moving into service also known as the *service paradox* or *servitization paradox* (Neely, 2009; Neely, Benedetinni, & Visnjic, 2011). This paradox may appear when companies invest heavily in extending their service business, increase their service offering, and incur higher costs, which does not necessarily result in higher returns (Gebauer & Friedli, 2005). As explained by Oliva and Kallenberg (2003), one of the challenges with providing services remains within the pricing mechanisms as the pricing of these services should be based on equipment availability, and not on the provider's costs of monitoring, maintaining, and repairing the equipment. Profitability under this pricing mechanism therefore depends on how accurate the provider is in assessing the equipment's risk of failure. As most organizations do not sit on the historical data to predict failure rates, a new set of skills e.g. information gathering capabilities is required to better determine risks. This supports the service paradox as service providers may have to take unprofitable maintenance contracts in pursuit of obtaining such skills (Oliva & Kallenberg, 2003).

While exploring the financial consequences of servitization in 10,846 manufacturing firms where 30% were considered servitized, Neely (2009) discovered that out of the 212 firms that had declared bankruptcy -53% of them had servitized, thus supporting the assumption of the paradox. Neely (2009) however, argued that there could be an alternative explanation to this as some manufacturing firms which already had financial difficulties might have chosen to servitize in an attempt to solve their problems.

2.1.4 The Process and Forms of Servitization

According to Oliva and Kallenberg (2003), the expansion of service offerings can take place once two distinctive transitions have been implemented. The first transition is to change the focus of customer interactions from transaction- to relationship-based services. This movement changes the way services are priced, from mark-up for labour and parts whenever this is provided, to a fixed price covering all services over an agreed period. The purpose of such a contracting method is that the service provider stands responsible for the risk of equipment failure. Maintenance contracts are one of the most common in relationship-based services and are often priced in terms of operational availability and response time in case of failure.



The second transition should be to change focus of the value proposition over to the user, from product efficacy, to the product's efficiency and effectiveness within the processes of the enduser (Oliva & Kallenberg, 2003). The product itself will become a part of the total offering instead of being the main source of value - shifting focus from machine manufacturer to solution provider (Oliva & Kallenberg, 2003). These transitions have been coined the productservice continuum, and a variety of forms of servitization strategies with differing features have been discussed along this continuum (Baines et al., 2009; Gebauer & Friedli, 2005; Neely, 2009; Neu & Brown, 2005; Oliva & Kallenberg, 2003; Tukker, 2004). The continuum ranges from traditional product orientation where services are simply an add-on to the products, to result orientation where services generate the main source of value and may or may not include tangible goods as add-ons (Baines et al., 2009; Tukker, 2004).

Neely et al, (2011) illustrates the servitization process as a shift in five underlying trends, shown in Figure 2-1. They explain how this illustration is not intended to suggest that products will be replaced by solutions, nor will transactions be replaced by relationships, but rather to emphasise solutions that are supplementing products and relationships are supplementing transactions. As firms servitize, they are expected to provide solutions that in one way or another will support or complement their product. The

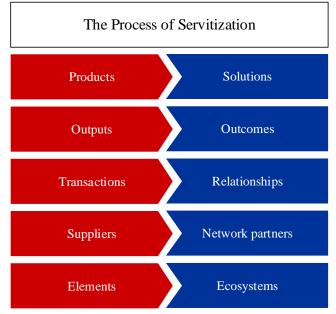


Figure 2-1, The process of servitization (Neely et al., 2011)

provider is often driven to offer more complex outcome-based contracts e.g. guaranteeing the uptime and availability of the product (Neely et al., 2011). Outcome-based contracts in this manner are often long-term, thus moving away from transactions towards long-term relationships (Neely et al., 2011).

The concepts of servitization and *vertical integration* are closely related (Baines, Lightfoot, & Smart, 2011). Vertical integration is usually known as "the extent to which a firm owns and takes responsibility for its upstream suppliers and its downstream customers" (p. 7). Baines et al. (2011) argue how this is especially the case for long-term contracts such as the ones mentioned above, resulting a network of partners being developed (Neely et al., 2011).



As noted by Vandermerwe and Rada (1988), servitization is not circumscribed to manufacturers and other product firms, although this is a common perception in the literature (Kowalkowski, Gebauer, Kamp, & Parry, 2017). To complement this, Kowalkowski et al. (2017) argue that service sector companies may also servitize where firms move away from constructs associated with service provision. An example is presented in the field of banking where banks often retain a product logic – maximising sales and distancing themselves from their customers through digitalisation and automation. This logic is built on a product-centric mindset and business logic (Kowalkowski et al., 2017) which implies that the firm primarily perceives itself as an entity that develop and sell products, regardless of its share of services (Kindström & Kowalkowski, 2014). From the perspective of service logic, there is more emphasis on user needs and expectations, value proposition e.g. through closer customer interaction, and solution-oriented towards customers with a service-centric mindset (Ahamed, Inohara, & Kamoshida, 2013; Kindström, 2010).

Knowing that the process of servitization is the evolution of product identity based on material content to a position where the tangible is inseparable from the intangible service system, it is worth mentioning the process of *productization*. Here a service provider moves the opposite direction in the continuum, and is seen as the modification of a service to include a product or a new service component that can be commercially sold as a product (Baines et al., 2007).

Tukker (2004) constructed a model upon the continuum mentioned above which contains three forms of Product-Service Systems (PSSs) where PSS is defined as consisting of "tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs" (p. 246). A PSS can therefore be seen as what a firm is offering and how it is offered as a result of servitizing, where Baines et al. (2007) however state that "a Product Service-System is a special case of servitization, which values asset performance and utilization rather than ownership, and achieves differentiation through the integration of product and services that provide value in use to the customer" (p. 1551). Neely (2009) holds a similar view of PSSs along the discussed continuum as Tukker (2004), but reckoned that an extension of the model was required to fully represent the range of servitization strategies, therefore including the aspect of ownership in Baines et al. (2007) statement. The extended version of this model is visualised in Figure 2-2, and a description of the five strategies is presented in Table 2-1.



PSS	Description
Integration	Ownership of the tangible product is transferred to the customer, but the supplier
oriented	seeks vertical integration by added services, thus going downstream. i.e. product plus
	service.
Product	Ownership of the tangible product is still transferred to the customer, but additional
oriented	services directly related to the product are provided. i.e. product plus service that are
	integral to the product.
Service	Ownership of the tangible product is also here transferred to the customer, but
oriented	additional value-added services are offered as an elemental part of the offering by
	incorporate services into the product itself. i.e. coupled product and service.
Use	A shift of focus towards the service itself which is delivered through products.
oriented	Ownership of the tangible product often remain with the service provider, who sells
	the functions of the product. i.e. intangible service with utilisation of tangible
	products.
Result	The customer and the provider in principle agree on a result, seeking to replace
oriented	product with service, thus removing the need for the product altogether. i.e. intangible
	service that may replace the tangible product.

Table 2-1, Forms of servitization with a description of five product-service systems (Neely, 2009; Tukker, 2004)

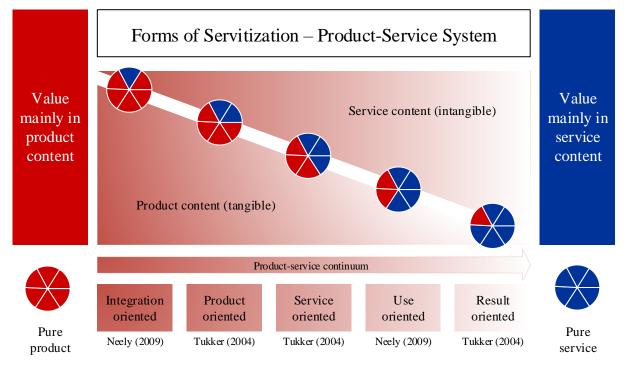


Figure 2-2, Forms of servitization in the product-service continuum (Neely, 2009; Tukker, 2004)



2.2 Digitisation, Digitalisation, and Digital Transformation

In recent years, industries have been facing technological shifts where volatile markets inhibit the need for better response to demand, pushing businesses to seek agility and optimise performance by changing the way people work (Henriette et al., 2015). Digitalisation has been identified as one of the major trends that will in the near and long-term future change society and business (Parviainen et al., 2017), where the widespread appliance of digitalisation have been coined the third industrial revolution¹ (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014).

Digitalisation and digitisation are two conceptual terms that are closely related and often used interchangeably (Windpassinger, 2016), though they are per definition quite different. Digitisation refers to "the process of converting analog signals into a digital form, and ultimately into binary digits (bits)" (Tilson, Lyytinen, & Sørensen, 2010, p. 749), which can potentially make physical products or objects programmable, addressable, sensible, communicable, memorable, traceable, and associable (Yoo et al., 2010). Digitalisation on the other hand, is the "use of digital technologies and of data (digitized and natively digital) in order to create revenue, improve business, replace/transform business processes (not simply digitize them), and create an environment of digital business, whereby digital information is at the core" (Windpassinger, 2016).

In this thesis, where there is more focus on the organizational changes in the process of digital servitization, the term of digital transformation must be clarified. Digital transformation is "the profound transformation of business and organizational activities, processes, competencies, and models to fully leverage the changes and opportunities of a mix of digital technologies and their accelerating impact across society in a strategic and prioritized way, with present and future shifts in mind" (I-SCOOP, 2015). Based on the mentioned definitions it is clear how without digitising, no form of digitalisation nor digital transformation can prevail (Windpassinger, 2016).

According to Parviainen et al. (2017), digital transformation will imply changes in roles, ways of working, and business offerings caused by digital technologies being adopted in the

¹ The three industrial revolutions of the past were all triggered by technical innovations: 1st the introduction of water and steam powered mechanical manufacturing (Brettel et al., 2014), 2nd the intensive use of electricity lead to mass production (Rüßmann et al., 2015), and 3rd the widespread of digitalisation which enabled automated manufacturing (Lasi et al., 2014; Rüßmann et al., 2015).

organization or in the environment the organization operates. They further describe how these changes are referred to the following four levels:

- *Process level* adopting digital tools and improve processes by reducing manual steps.
- Organization level offering new services, discarding obsolete practices and offering existing services in new ways.
- Business domain level changing roles and value-chains in ecosystems.
- *Society level* changing society structures e.g. type of work and means to influence decision making.

2.2.1 Explanation of Key Terms

Within the field of computer science, there exists an excessive amount of terms with diffuse and different definitions due to rapid expansion and frequent change in technologies (Yoo, 2010). A selected few of these terms relevant to this thesis, are explained in Table 2-2.

Digital Technology	Description
Information	The products, methods, inventions, and standards that are used for producing
Technology (IT)	information (data). IT apply to hardware, software, and data components.
	(Kroenke, 2011, p. 31)
Information System	A particular type of work system that uses IT to capture, transmit, store,
(IS)	retrieve, manipulate, and/or display information (Alter, 2002, p. 6). IS can
	also be seen as an assembly of hardware, software, procedures, and people to
	produce and manage information (Kroenke, 2011, p. 31).
Information	All devices, network components, applications, and systems that in unity
Communication	allow people and organizations to interact with the digital world (Rouse,
Technology (ICT)	2017).
Digital	The basic information technologies, organizational structures, services, and
infrastructure	facilities necessary for an industry or organization to function (Tilson et al.,
	2010).
Bandwidth	The capacity of a telecommunications channel stated in megabits or gigabits
	per second (Alter, 2002, p. 406-407). i.e. the amount of data possible to
	transmit per time unit.
Big Data	Data sets with sizes beyond the common software tools ability to capture,
	manage, and process it within a tolerable period (Snijders, Matzat, & Reips,
	2012).

 Table 2-2, Some key terms in the field of computer science



Cloud Computing	A model for enabling on-demand access to a shared pool of computing		
	resources e.g. networks, servers, storage, applications, and services over the		
	internet (Mell & Grance, 2011).		
Internet of Things	A variety of things or objects such as RFID tags, sensors, actuators, mobile		
(IoT)	phones, etc. which, through internet connectivity are able to interact		
	autonomously with each other and cooperate with their neighbour things and		
	objects to reach common goals (Atzori, Iera, & Morabito, 2010). Also known		
	as smart objects, smart artefacts, and smart, connected products.		
Internet of Services	A system that, as a result of IoT will systematically make use of the internet		
(IoS)	for new ways of creating value across all industries in the service sector		
	(Huxtable & Schaefer, 2016).		
Virtual Reality	An artificial environment created with software and presented to the user in		
(VR)	a way that the user views this environment as real (Rouse, 2015). This is		
	primarily presented through VR-glasses capable of displaying a perception		
	of depth.		
Augmented Reality An enhanced version of reality where live view of real-world			
(AR)	are augmented with computer-generated images, thus enhancing one's		
	perception of reality (Reality Technologies, 2016). This can be presented in		
	a similar way as VR though the glasses are transparent making the real world		
	visible as well, or through handheld devices which uses a camera as a tool		
	for transparency.		

2.2.2 Why are Organizations Digitally Transforming?

As technology have in the last decades been a victim of rapid evolvement, IT and ICT elements have become more reliable and powerful, and less costly, sized, and power consuming, which by itself increases the possibility to digitise key functions and capabilities in different industries (Yoo et al., 2010). Products and services with embedded digital capability by their extraordinarily improved price:performance ratios will inevitably alter their design, production, distribution, and use (Yoo et al., 2010). Though there are considerable reasons for organizations to implement digital technologies, Kane et al. (2015) identified in their survey of over 4,800 executives, managers, and analysts from organizations around the world that transforming the business, improving innovation, improving business decision making, increasing efficiency, and improving customer experience and engagement were of the top reasons for implementation. However, their findings show that organizations pursue digital transformation



in different degrees with distinct focus' based on their *digital maturity* where the degree of maturity (less to high) respectfully emphasises the different drivers.

The term of digital maturity can be separated into two related dimensions; *digital intensity* and *transformation management intensity* (Westerman, Tannou, Bonnet, Ferraris, & McAfee, 2012). The former considers changing how the company operates in the fields of customer engagement and internal operations by investing in technology-enabled initiatives, which may potentially disrupt the business model. Whereas the latter revolves around creating the leadership capabilities necessary to drive digital transformation through vision, engagement, governance, and addressing the relationship between IT and business (Westerman et al., 2012). By comparing companies with diverse digital maturity, Westerman et al. (2012) found that the ones with stronger digital intensity derive more revenue from their assets, and with stronger transformational management intensity the companies were more profitable. Companies that were considered mature in both dimensions proved to be superior to their less mature competitors in terms of performance, revenue, profit, and market valuation.

According to Parviainen et al. (2017), the potential benefits of digitalisation remains in the fields of internal efficiency, external opportunities and disruptive changes, and points out that neglecting a digital transformation in highly competitive markets could generate the risk of being ousted. These benefits are explained in Table 2-3. Additionally, due to the inexpensiveness and widespread of ICT, IS, and IT in general, the digital is extremely scalable and flexible by nature (Tilson et al., 2010).

Table 2-3, Potential benefits of digitalisation (Parviainen et al., 2017)

Field	Potential benefits	
Internal	By eliminating manual steps through automation and utilisation of digital tools,	
efficiency	processes can improve in terms of efficiency, quality, and consistency. As routine	
	work becomes automated, resources are released resulting in employees having	
	more time to develop new skills and being enabled to focus their energy elsewhere	
	which again may boost job satisfaction. With more elements of the organization	
	being digitised, digitalisation can facilitate better real-time view on operations and	
	results by collecting and analysing more data from several sources. Such data can	
	provide an organization with information to gain better accuracy within processes	
	and reduce the chances of data being corrupted or lost via standardisation of records	
	and easier backups.	



External	With the implementation of communication technologies and tools for capturing	
opportunities	and analysing data, response time and client service may be improved. It can also	
	introduce the organization for new ways of doing business and can potentially create	
	opportunities for new services or advanced offerings to customers.	
Disruptive	Digitalisation may provoke the operating environment of a company or industry to	
changes	alternate, causing current businesses to become obsolete. Though such changes can	
	be negative for some, digitalisation in a fast-evolving market can create completely	
	new businesses that may replace the old ones for the better.	

2.2.3 Challenges in Digital Transformation

Even though the importance of digitalisation is widely recognised, companies often struggle to grasp the impacts and benefits of a digital transformation as well as addressing the numerous challenges in the transformation process (Parviainen et al., 2017). The strengths of digital technologies does not lie in the technology itself, but rather on how companies integrate them to transform their business and exploit its benefits (Kane et al., 2015). In many cases, the transformation has been unsuccessful due to organizations not being able to change mindsets and processes or build a culture that could cultivate it (Parviainen et al., 2017).

Similarly with the different drivers, the challenges also imply to be distinctive to the digital maturity of the organization (Hoberg, Krcmar, Oswald, & Welz, 2015). According to Kane et al. (2015), the overlying challenges lies within strategy, culture, and leadership to drive the transformation through a clear digital strategy, and also notes a lack of research regarding how to manage digital transformation projects.

More specifically, Kane et al. (2015) identified lack of strategy, too many priorities, and lack of management understanding to be the top challenges for less mature companies; too many priorities, lack of strategy, and insufficient tech skills for the more mature; and too many priorities, security concerns, and insufficient tech skills in the most mature organizations. The subject of a lacking strategy revolves around the organization's ability to communicate a clear strategy for everyone to understand and aid the transformation and is recognised as the major obstacle to digital maturity in the early stages. As companies digitally mature, a vast number of possibilities and concerns present themselves which may result in there being too many competing priorities concurrently.

In their research, Hoberg et al. (2015) identified cross-functional knowledge between IT and business to be a prerequisite for developing a proper digital transformation strategy, where



Westerman et al. (2012) concluded knowledge of this IT:Business relationship to be key for success. Kane et al. (2015) suggest the talent challenge to be more intense for less mature organizations where digital leaders and managers must possess an understanding of technology to greater conceptualise the transformation's potential and ensuring its impact. They further explain how technical skills will be more relevant as companies mature, e.g. enabling the use of digital tools and systems more efficiently. Digitalisation will, according to Lerch and Gotsch (2015a) significantly increase the complexity, abstraction, and problem-solving skills needed by employees. Though in the past, where users' training and acceptance have been important issues regarding technology, Yoo (2010) argued this to be an irrelevant issue for the future as the emerging generations have used computing capabilities for much broader purposes than previous generations, therefore naturally possessing higher technical skills and will take the notion of technological acceptance for granted.

2.3 Digital Servitization

Though it is possible to move toward providing services without digitising the offer, and to digitise an offer without providing it as a service, Vendrell-Herrero et al. (2017) argued there to be a strong interaction between servitization, digitising, digitalisation and digital transformation. Several researchers have identified this interaction to be a yet unexplored subject in the academia (Coreynen et al., 2017; Grubic, 2014; Lerch & Gotsch, 2015a; Paschou et al., 2017; Vendrell-Herrero et al., 2017).

The two trends of servitization and digitalisation are now converging (Frishammar, Dasselaar, & Parida, 2015) where the convergence may have been triggered by a higher need for customisation and efficiency in providing service offerings on a global scale (Cenamor et al., 2017). The increasing interest and research about digital technologies' role in servitized products have set the path for *digital servitization* to flourish, where digital servitization is formally described as "the provision of digital services embedded in physical products" (Vendrell-Herrero et al., 2017, p. 69).

Due to ICTs vast potential in appliance, research communities on servitization have together reckoned digitising and digitalisation to be key enablers for the implementation of new service offerings to potentially become less challenging and more successful (Akram, 2012; Cenamor et al., 2017; Frishammar et al., 2015; Huxtable & Schaefer, 2016; Lerch & Gotsch, 2015a; Paschou et al., 2017; Porter & Heppelmann, 2014; Vendrell-Herrero et al., 2017). In this regard, being enabled to provide offerings with higher complexity and degree of customisation and be



better equipped to fulfil customer's needs. Additionally, by utilising ICT tools, service providers can improve their internal and external processes and capabilities through better information gathering, information analysis, and sharing of knowledge.

2.3.1 Enhanced Offerings, Processes, and Capabilities

As mentioned, there are enormous potentials in digital services as digital tools combined with IoT (smart objects) present numerous opportunities and benefits. Porter and Heppelmann (2015) state that the range of potential new services enabled by smart objects is limited only by imagination and argues that the uprising of such objects will affect structures in countless industries, where the effect will be greater for industries involved with manufacturing. This will ensure a leap in productivity as a result of these new and better products, which causes valuechains to be reshaped by altering product design, marketing, manufacturing, after-sale services, and creating new activities such as product data analysis and security (Porter & Heppelmann, 2014).

Porter and Heppelmann (2014) articulate these smart objects to consist of three components. The physical comprises the mechanical and electrical parts of the product. The smart components such as sensors, microprocessors, data storage, controls, software, and an embedded operating system and enhanced user interface. And lastly, the connectivity which through ports, antennae, and protocols enable wired or wireless connection with the product. They further grouped the capabilities of these smart objects into the four areas of *monitoring*, *control, optimisation, and autonomy, and describe the areas as presented below.*

In monitoring, companies can oversee the products condition, operation, and external environment via sensors and external data sources. Using this data, the user can be alerted if changes occur in circumstances or performance, as well as being enabled to track the actual usage and history of the product. This data can present new opportunities such as:

- Important implications for designing the next generation of products. •
- Market segmentation through analysis of usage patterns at different customers. •
- Improved after-sale services by dispatching the right technician with required tools and • parts.
- Reveal warranty compliance issues as well as new sales opportunities, such as the need for additional product capacity due to high utilisation.



With control, the smart objects may be controlled through remote commands and algorithms that are either built into the product itself or residing in the product cloud. Algorithms are rules that intends to direct the product to respond to specific changes in condition or environment e.g. open valve if pressure gets too high. Control through software embedded in the product or in the cloud allows for customisation of performance in ways not possible before and enables users to control and personalise their interaction with the product in new ways.

Optimisation refers to the ability to dramatically improve output, utilisation, and efficiency. For instance, a local microprocessor or "brain" in wind turbines can adjust each blade on every revolution to capture maximum wind energy. Real-time data on product condition and control capability enables service providers to optimise their offering by performing preventive maintenance when failure is probable and could potentially be repaired remotely, therefore reducing product down-time and the need to dispatch technicians. Even when on-site repair is required, advanced information about what is broken, what parts and tool are required, and how to perform the repair in a most efficient way reduces costs and improve first-time fix rates. Figure 2-3 illustrates how AR may be utilised in this manner (see 2.2.1 for a description of AR).



Figure 2-3, "Augmented Reality Goes To Work" (Dickson, 2017)

By combining the capabilities of monitoring, control, and optimisation allows for smart objects to attain a level of autonomy. These highly sophisticated products can learn about the



environment which they operate in, self-diagnosing their own service needs, and potentially adapt to the users' preferences. This kind of autonomy not only reduce the need for operators but can improve safety in dangerous environments and facilitate operation in remote locations.

With an increasing number of smart objects being connected to the internet that generate vast amounts of data, a strong digital infrastructure with suitable bandwidth will be a prerequisite for such a system to function (Porter & Heppelmann, 2014). Building and supporting the technology behind smart objects requires substantial investments in a range of new skills, such as software developers, systems engineers, data analytics, and online security expertise traditionally unheard of in manufacturing (Porter & Heppelmann, 2014).

While researching the big data element of IoT, Huxtable and Schaefer (2016) found some additional opportunities for businesses to potentially exploit. With the tremendous amounts of data generated and obtained, companies could re-sell data to third parties, sell their core competence in analytics by consulting other firms in different industries on how to harness big data, and with access to advanced analytics tools they could outsource these as a service for other firms to utilise.

According to Frishammar et al. (2015), technological innovation manifested in smart objects and integrated product-services will radically reshape companies, value-chains, industries and ultimately the whole world. This radical change have in the academia sometimes been referred to as the fourth industrial revolution, or Industry 4.0 (Rüßmann et al., 2015).

2.3.2 Digital Servitization Transformation Framework

Lerch and Gotsch (2015b) assumed in their study that there is a positive relationship between the degree of digitalisation and the level of servitization and concluded that a higher service orientation with more complex offerings led to a greater need for digital solutions. Based on their findings, a framework was constructed to differentiate four stages in a transformation process that emphasises these subjects (Table 2-4 and Figure 2-4).



Table 2-4, Digital servitization transformation framework (Lerch & Gotsch, 2015b)

Stage	Description		
Manufacturer	Manufacturers at this stage provide product-related services, such as		
	installation or maintenance and repair. Standard ICT solutions are used to		
	support services and are embedded in daily work. However, these solutions		
	have minor impact on how the offerings are differentiated in the market.		
IT-based services	At this stage, the ICT solutions are used to improve existing service offerings		
	e.g. monitoring and controlling distant machines resulting in the companies		
	being able to provide faster services with higher quality and less resources.		
Pure digital Here, services are enabled by ICT systems such as software-based sir			
services	VR and AR applications, and digital technical analysis. These services may		
	extend the business' service offerings and significantly improve the		
	performance of the service or product that is the core offering.		
Digitalised	At the final stage, manufacturers not only provide a complex PSS but also		
Product-Service	incorporate ICT solutions as a novel component in the product-service bundle,		
Systems	creating intelligent independent operating systems that deliver the highest level		
	of availability possible and optimise operations while reducing the input of		
	resources.		

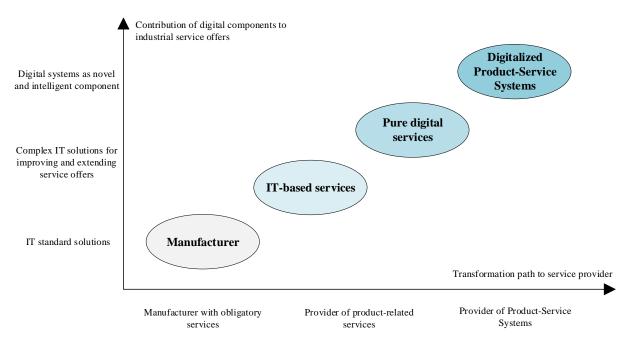


Figure 2-4, Digital servitization transformation framework (Lerch & Gotsch, 2015b)



2.4 Framework of the Research

In this research I seek to answer the question of "what organizational changes occur when firms utilise digital technologies to move from being product-oriented to become more serviceoriented, and which digital technologies could be used in this regard?". As literature surrounding servitization has acknowledged there to be challenges in the organizational dimensions of culture, human resources, processes and capabilities, strategy and strategic alignment, and network (2.1.3), these were some of the areas I want to focus on. However, the aspect of culture is something several researchers seem to be interested in, which has lead to be more research in this area. From the perspective of digitalisation and digital transformation, strategy, culture, and leadership (2.2.3) were of high concern. Authors also expressed the lack of research regarding how to manage digital transformation projects.

Though this research aims more over to the subject of digital servitization, the main focus of this thesis lies in the intersection between digitalisation and servitization. Paschou et al. (2017) argued that research conducted on the two concepts have been developed in isolation over the years, where their possible intersection has only recently been recognised. This recognition implies researchers to see the potential of specific digital technologies such as remote monitoring, predictive analysis, IoT, cloud computing, and big data. Despite the general agreement that utilising aforesaid technologies could improve and accelerate the servitization process, reshapes industries, and enable novel product-service offerings, little attention has been set to understand how this can be achieved (Paschou et al., 2017). It will be interesting to see how such technologies are utilised in practice, what organizational changes occur in this process, as well as an attempt to find are any other technologies and methods exploited in this manner.

To be able to obtain an understanding of how organizations and industries are transforming when utilising digital technologies to become more service-oriented, a framework has been constructed to show a visual representation of the focus in this research (see Figure 2-5). Even though the aspect of culture is often discussed in servitization context, it is still included in this thesis as it might be different in digital servitization. The reason for every other element in the framework is to potentially reveal practises and lessons from the real world that could help gain an understanding of why and how organizations do what they do in the process of digital servitization, hopefully exposing best practices within this field.



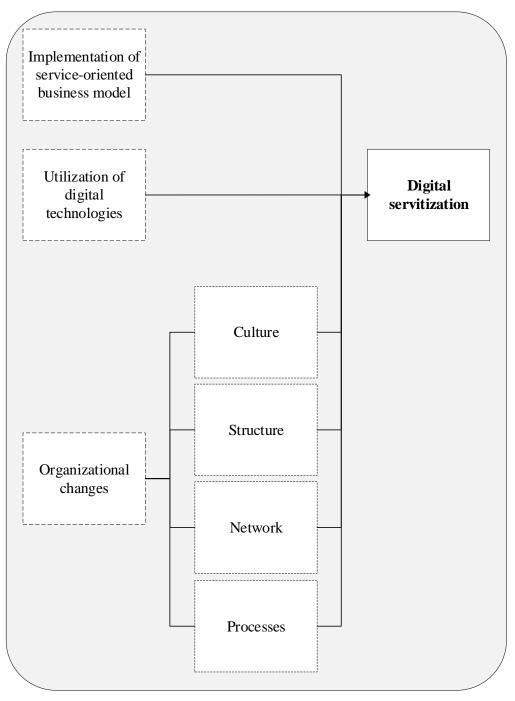


Figure 2-5, Original framework for the research

3 Research Method

To explore the process of digital servitization in practice, a qualitative multiple case-study using semi-structured interviews have been conducted. My research approach can be seen as abductive, which implies having elements from both inductive and deductive approaches but with more emphasis on the former. Deduction was utilised to acquire a general understanding of the concept of digital servitization through other's research, identifying a gap in knowledge, which further functioned as the foundation for my research question. Induction on the other hand, was used to attain an even deeper understanding from the empirical data generated from the multiple case interviews for the sole purpose of filling the acknowledged gap or potentially revealing something unheard of.

3.1 Approach to Collect Data

The collection of data in this thesis has been carried out as a qualitative multiple case-study and was performed in this manner for different reasons. Firstly, due to the lack of existing empirical data on the subject, Yin (2006) argues a qualitative method approach to be more suitable. Secondly, it allowed me to alter direction and focus when carrying out the study. This flexibility was favourable because of how little I knew before each interview. According to Bryman (2016, p. 379), this enables the possibility of adjusting the theoretical foundation and the researcher's perspective of what seems to be interesting in the empirical analysis. In retrospect, this approach was an important part of the research method as it made my thesis somewhat dynamic, allowing me to adjust and alter some aspects of the research when a state of stagnation arose or when new and more interesting views revealed itself.

3.1.1 Case-based Approach

Yin (2006, p. 13) articulate case-studies to be more suitable for investigating a complementary phenomenon within real-life context, especially when the boundaries between phenomenon and context are unclear. He also refers to case-studies as more prominent in the investigation of implementation processes and organizational changes, which is mainly why this method was chosen to better capture important data in this regard. According to Dawson (1996), it is only through empirically rich detailed case-studies that the contradictory processes of change can be identified and examined. I therefore chose to study several cases to which an implementation of servitization was in progress, allowing me to compare different approaches and attain an understanding of the phenomenon in relation to different cases. In this situation, where more than one case at a single point in time is studied (known as multiple case-study), and looking at



The main goal of interviewing different firms was not to compare the different cases to each other, but to obtain a collection of practises to understand how these companies handle and execute the servitization process with the utilisation of digital technologies. However, by comparing these findings and the different cases to one another, it could potentially reveal insightful information for managerial implications, further research, and the research in general. The multiple case-study approach was also chosen due to its low-effort approach for the companies involved which increases the probability of gaining access to interesting cases. When sampling the different firms, the sector or industry of which they operate in was deemed somewhat irrelevant to increase the chances of permitting a generalisation of the findings transversal to the industries.

The quality of data and findings in research are often referred to the three areas of validity, reliability, and generalisability. Though these are perceived as highly relevant in assuring the quality of quantitative research, some argue their relevance to be of less importance for qualitative research (Bryman, 2016, p. 383); therefore excluded in this study.

3.1.2 Sampling Cases and Informants

The sampling of context, participants, and informants have been done as a form of purposive sampling, meaning that the different companies was selectively chosen by predetermined criteria to improve the chances of the research question to be answered (Bryman, 2016, p. 407-415). The sample size was intentionally kept be small in the beginning to utilise the effect of snowball sampling which implies having the selected informants pointing me in the direction of others that could potentially sit on insightful information relevant for my research (Bryman, 2016, p. 416-416). By doing so, I gained access to new cases and informants both within and outside the boundaries of the selected organization after the first round of interviews were conducted. As a starting point, the criteria for whom to be interviewed was set as followed:

A company that is in the process of transforming their business to become more serviceoriented who provide services on a global scale, with a preferred variation in; industry, size, degree of technology embedded in offerings, and level of digital maturity.

In 2018, I would argue that there are many companies that seek to implement a higher serviceorientation which allowed me to approach several different organizations. However, as my research question is aimed more towards the midst of the transformation process, the selected



participant would have to be somewhat experienced or at least knowledgeable of the transformation taking place in the business over the last few years.

To be better enabled to capture important information, there was sought to be a variety in the cases, though similarities are present to make sure they are relevant to the field of research. Their relevance was identified by reviewing an existing network of potential cases, and by looking over the organization's annual reports for the last few years to compare revenues from products and services. By comparing annual reports from a given company, I was able to identify if the firm had lately changed their focus more over to services, as well as obtaining information which could be applicable to bring up in a potential interview. In addition to looking at annual reports, I reviewed their websites to identify their range of services, thus authenticating their relevance and gaining more related information for the interview.

Regarding the existing network of potential cases, elements of convenience sampling exhibits by the virtue of its accessibility (Bryman, 2016, p. 187). In practice, this consisted of me talking to family and friends about my research and what I was looking for. This helped me gain access to relevant cases through recommendations and personal relationships. Even though I only had personal relations to two of the informants, the personal relationships between someone I knew and the person they recommended me to was experienced as valuable due to these people being perceived as more enthusiastic and forthcoming.

When contacting the different companies, e-mails and telephone calls were the main channels for communication; focusing first and foremost on pre-existing network, though others I had no previous relations with were also contacted to increase the range of potential cases. In general, the ones I reached out to were interested in the subject of my research where I received positive response from everyone. However, there was one electronics company I never got to interview. In this case, whenever I engaged contact with one employee, I was forwarded to another. This went on through a handful of people which ended with the final potential informant not wanting to participate and ceased contact.

The process of being forwarded to another than the one initially engaged with, was not perceived as negative. On the contrary, by informing the first point of contact about some of the intentions of the research and its content, it improved the chances of gaining an audience with someone more suited to answer the questions. Some information was intentionally withheld to ensure that the informant would speak frank and freely, which prevents rehearsed explanations and answers. Out of the eight companies I contacted regarding this thesis, all



expressed some degree of interest in the subject. However, one ceased contact as mentioned above, and two companies who are involved in production, use, and advisory of smart objects did not have the capacity to be interviewed. This resulted in a total sample of five companies. Unfortunately, the cases I ended up with did not represent a variation in industries as originally intended. To cope with this, I sought to attain an audience with IT consultants who could potentially give valuable information from another perspective in a wide range of industries, as well as being more capable of discussing the subject of digital technologies which is essential for this research. In retrospect, the consultants gave insightful information in areas the other interviews did not cover, bringing more depth to the digital aspect of this research.

An audience with one of these IT consultants was a result of the snowballing method where an employee from Solutions Provider A pointed me in this direction. This method was also used to gain access to additional informants within two of the case companies. In Engineering Company, the Product Manager sent me to one of their Senior Purchasers who was more capable of answering questions regarding logistics. And in Shipyard Company, the VP arranged a meeting with three Contract Coordinators within the firm who worked in the service department and had great knowledge of a specific service they provided. An overview of the final selection of cases are summarised in Table 3-1, and a minor description of the companies are presented in Table 3-2.

Company	Informant(s)	Industry (NACE code)
Solution Provider A	Chief Engineer	Oil Service
(SPA)		(Manufacture of machinery for mining,
		quarrying and construction)
Solution Provider B	CEO	Oil Service
(SPB)		(Engineering activities and related technical
		consultancy)
Solution Provider C	Operations Director	Oil Service
(SPC)		(Manufacture of machinery for mining,
		quarrying and construction)
Engineering Company	Product Manager	Maritime
(EC)	Senior Purchaser	(Manufacture of other pumps and
		compressors)
Shipyard Company	VP Service	Maritime

Table 3-1, Overview of selected companies and informants



(SC)	Contract Coordinator x3	(Building of ships and floating structures)
IT Consultant A	Managing Consultant	IT
(ITCA)		(Business and other management consultancy
		activities)
IT Consultant B	Associate Director	IT
(ITCB)		(Computer consultancy activities)

Table 3-2, Minor description of the case companies

Company	Description	Size
Solution Provider A	A manufacturer and provider of oilrig systems where they	Large
	deliver close to everything which is above sea level and provide	
	services as a part of this system.	
Solution Provider B	A manufacturer and provider of equipment to the industry of oil,	Small
	where their units and coupled services are meant to cover all of	
	their customers' needs.	
Solution Provider C	A manufacturer and provider of hoses and coupling for the oil	Small
	industry which is delivered through "free" services.	
Engineering Company	A designer and provider of ballast water treatment systems for	Small
	the maritime industry with coupled services.	
Shipyard Company	A manufacturer and provider of lifeboats for the industries of oil	Large
	and maritime with coupled services.	
IT Consultant A	Consultant agency that focuses on continuous improvement of	Small
	operations and businesses with emphasis on digital	
	technologies.	
IT Consultant B	Consultant agency within digital technologies.	Large

3.1.3 Qualitative Interview, Semi-structured

I have used semi-structured approach when interviewing the informants due to its capability of offering a flexible interview process (Bryman, 2016, p. 467). This approach is intended to have the informant frame their answers according to the context of where they work or live (Dalland, 2017, p. 65). Such interviews are better equipped to generate deeper insight of a phenomenon compared to structured interviews; as semi-structured interviews are more open-ended, emphasising the interviewees own perspective, his or her opinion on what is relevant and important, and having the ability to alter the interview's direction (Bryman, 2016, p. 466-467).



Because the focus of what is to be researched is fairly clear, Bryman (2016, p. 469) argues semistructured interviews to be more suited, in addition stating that in multiple case-studies some form of structure is necessary to ensure cross-case comparability.

The interview guide (see A.2 – Interview Guide) was constructed as a table for the sake of simplicity and visual overview regarding themes, main questions, and follow-up questions. The first theme was meant to help me understand the informant's role, his experience, and the organization's business in general. The next theme was about the changes that have occurred in the company's business model as a result of a higher service-orientation, which was intended to have the informant talk about their products, services, and their connection, thus indirectly explaining where in the product-service continuum (Figure 2-2) they were located. This would give me the opportunity to ask related questions to the connection between their products and services and what they were planning for the future, e.g. if they sought to move even further in the continuum, which additionally could reveal some strategy aspects focused in this research. Throughout the different themes in the guide, the changes in the five underlying trends of servitization (Figure 2-1) were highlighted to have the informant explain what this meant for their organization and what practises were performed to permit these changes. The last theme focused on the organizational changes that had occurred due to the implementation of a serviceoriented business model regarding culture, structure, and network, with focus on digital technologies which was explained in 2.4 as the framework for this research. The aspect of processes did not get a designated section in the interview guide as it occurred naturally throughout the interview.

A favourable trait of the semi-structured interview was that I could operate more freely, using what the informant said to guide the interview as well as allowing the informant to bring up themes and cases not present in the interview guide (Tjora, 2012). Some of this information gave new insight to areas that had not yet crossed my mind which helped me adjust the guide's content for later interviews. As the interview became more of a discussion, jumping back and forth between themes, the structure of my guide helped me keep track of what was already discussed and what was missing by unchecking the follow-ups while the interview was in progress.

According to Tjora (2012, p. 107), the quality of semi-structured interviews depends on the level of trust between researcher and informant, especially when sensitive information will or could come up. He further argues that a level of trust is easier to attain if there is enough time to build up some degree of trust. In my case I had the interview designed and tested to last one



hour but experienced that several informants willingly went over time to discuss more than what I asked for, resulting in the interviews lasting somewhere between one hour and an hour and a half. In addition to building trust through friendly discussions, I always offered a declaration of consent (see A.1 – Declaration of Consent) which ensured the informant about my confidentiality in addition to practical information about how the data were to be managed.

Tjora (2012, p. 120) also articulate the importance of having the interview be conducted in a place where the informant feels safe, whereas I always asked to have it done within working hours at their office. This enabled me to talk to others in the office when the informant forwarded me to someone else that could answer a specific question better than what he/she could. It also gave me insight when it came to culture as I could see the landscape of the offices with my own eyes. Unfortunately, some interviews had to be conducted over telephone for the sake of simplicity and travel expenses due to remote locations. In the total sample of seven cases, three were done in this manner. My experience was that the face-to-face interviews were easier and more rewarding than the ones done over telephone as their reactions and expressions played a higher role than expected. By having the interview recorded, I ensured that all information was captured which made me more relaxed and focused on the discussion at hand, thus ensuring a more open a constructive dialog from both parties.

3.2 Analysis of the Qualitative Data

The analysis of data in this thesis is based on Miles and Huberman (1984) who considers data in qualitative research to consist of three concurrent flows of activities; data reduction, data display, and conclusion-drawing and verification. The authors refer to data reduction as the process of selecting, focusing, simplifying, abstracting, and transforming the raw data, which in my case are transcribed interviews. Data display is an organised and compressed collection of data retrieved from the reduction process which is something the researcher could potentially draw conclusions from. The final process, conclusion-drawing and verification consists of identifying patterns and explanations in the data relevant to the research question which is to be answered.

The first phase of my analysis, the data reduction phase, consisted of me going through all the transcriptions derived from interviews by categorising sentences and paragraphs relevant to the research with codes. The main codes where based on the framework from 2.4, and were set to Products and Services, Culture and Human Resources, Structure, Network, Processes, Capabilities, and Data, and Digital Technologies. While analysing the data, new and interesting



areas revealed themselves where the codes of *Operational Environment and Market* and *Laws and Authorities* were set as well. Each code was supplemented and connected with a minor description to gain a better visualisation and overview.

When coding the data was completed, the second phase of the analysis was to have the coded data displayed in a visual and clear way. With the data presented visually, I set out to group the coded paragraphs into subchapters in the findings chapter with corresponding titles as the main codes. This to identify patterns and reveal relevant information which could be drawn as a conclusion to my research question.

In the final process of conclusion-drawing and verification which in my case were mostly done pre-discussing and while writing the discussion chapter, I focused on looking at my findings in the light of the literature background and sought to identify where my study could contribute to the field of research and how this could answer my research question.



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4 Findings

The findings from the qualitative research will be presented in eight domains which to some extent proved to be relevant for the thesis and its contribution to the field of research. Some of the domains are initially based on the framework presented in 2.4 where new domains emerged after the analysis due to their prominent relevance to the topic of digital servitization. For the sake of simplicity, the Solution Providers (SPX), Engineering Company (EC), and Shipyard Company (SC) will sometimes be referred to as Manufacturing Companies (MCs) as the IT Consultants (ITCX) cannot be included in the same manner. Each person will be referred to as "he" for the same reason as well as securing confidentiality.

Many of the domains have elements that could be perceived as relevant to others where clear lines would be advantageous. However, the task of distinguishing what element to be presented in which domain was experienced as difficult due to their potential relevance to several domains. The findings will be presented in the best way possible, but a comprehensive view of this chapter would be beneficial for gaining a greater understanding. The first paragraph in each subchapter can be perceived as a minor description of what follows to easier grasp its content.

4.1 Products and Services

To obtain an understanding and overview of what types of products and services the MCs are providing and changes that have occurred in this aspect, this subchapter will seek to clarify some of the underlying trends in this manner.

Every MC are providing products and services on a global scale where every company is offering traditional services which is often referred to services such as spare parts, maintenance, and repair. Four out of five have been providing such services for as long as the companies have been operational, where the fifth included these in their business model to fulfil the wishes of the customer.

What happened after we had been selling and renting out our products for a few years? The customers came back to us and asked for spare parts, service, and maintenance by saying "you are the ones who built these, you are the most capable of maintaining them", well of course we are. – CEO, SPB

The CEO of SPB argued this to be a result of an increased focus on core business and core competence. This seemed to be the case for the MCs as well where four out of five have in the past years experienced some products to become obsolete due to the organizations seeking to



focus on a single core business. However, they were all aiming to increase their competence within the operating field of their products, thus increasing the scope of their core competence while preserving the core of their business. This escalation in scope was not to provide more products, but to improve their products and capabilities to enable new and better ways of providing services as well as the possibility of providing new and more complex services which were impossible before the technological advancements of the 21th century.

IT's role in our products are significant. All these new services we are providing have not been there from the beginning, but with an increasing focus on the digital in our product and its complementary services, new and more complex services have become possible. – Product Manager, EC

Some of these new and more complex services are made possible due to sensors, methods for gathering data and other digital technologies. With more data from several sources, two out of five have established 24/7 monitoring and control services to enable preventive maintenance, consulting, and addressing issues regarding warranty. The remaining MCs are planning for the same in the future but have not yet implemented it.

[...] there is also a high focus on providing digital services. This is mainly regarding the condition of the products itself, but another element is the environment in which the product is operating. This is about gathering data on what is supposed to happen, and what is happening as well as the reporting system surrounding it. – Chief Engineer, SPA

The collection of condition-based data from the products are meant to help the providers to improve their capabilities in preventive maintenance by analysing how the products are used, what alarms and errors are occurring, and thus be more capable of assessing potential risks. By collecting and analysing operational data, they could suggest how their customer's operations could be optimised as well as addressing warranty issues with more precision.

In our rental units, we use something called an event log. When a unit breaks down, a discussion about whose fault it is, is often brought up. Whose fault is it? The customer or the provider? What happened? Is it a regular wear and tear, or is it the user who has been operating it incorrectly? Once the event log was implemented, and we informed the user of its existence, the downtime in use were reduced by 70%. [...] We experienced there to be 70% less fuss and break downs in our equipment thanks to the event log, also avoiding the unhappy discussions about whose fault it was, where we often lost such discussions before the implementation of the event log. – CEO, SPB



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SPB is the only case company who is providing rental units where the others are selling them either as products or as a system. The reason SPB offers rentals is to have a complementary business model by attaining as much value as possible. He explains this by drawing the business model as shown in Figure 4-1. The equipment they are producing are highly complex and could cost as much as 10 million NOK per unit. Each unit can take up to seven months to

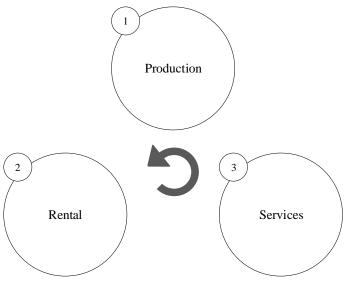


Figure 4-1, Simplified version of SPBs business model

produce where SPB offers rentals within this period as several customers want the equipment as soon as possible. Due to the enormous capital required to produce one unit, SPB are securing more income from rentals to go into the production of new units, thus avoiding the dependency of having a high disposable capital within the company as well as securing cashflow in a fluctuating market. Once the unit is produced, the rental unit is replaced, and the third part of the model is initiated.

This model is complementary, where I can offer the customer what he wants from the beginning till the end. [...] Look at it this way: The intention of this model is that the price of the product we are selling here (Production) can be reduced as we are re-gaining it later on, here (Services). Sales is a one-time payment, but the services are continuously running which gives us a constant cashflow. The equipment lasts for about ten years, where a customer will not buy a new one before those years have passed. I would say that here (Services) is the greatest potential for earning money. – CEO, SPB

In the case of renting, the ownership of the unit remains with SPB which is not the same as for the ones sold. Regarding ownership, none of the MCs are providing their system or products in a way that total ownership remains with the provider. However, every MC are looking at the possibilities of standing more responsible for the products condition and its efficiency and effectiveness within the processes of the user. Three out of five have over the last few years been able to withhold some of these responsibilities where the remaining two are seeking to do the same. They all looked at this as a subject to continuous improvement and wishes to be more responsible for their products in the future through new and more complex services.



Lately, we have experienced that we are in need of new ways of thinking because we are taking more responsibility for the condition of the equipment. Here we are going to ensure that it gets the necessary service and maintenance, where we want the customer to pay for the time the system is operational. – Chief Engineer, SPA

The traditional services can be seen as outputs as they are sold as an add-on to the product after the sale has been initiated. These new and complex services are based more on outcome as they are meant to bring additional value to the customer for the whole duration of the products lifecycle. This could be to improve the product's efficiency and effectiveness within the processes of the user, add digital services with low effort, and to improve the lifecycle of the products in general. As products and services are embedded with more electronics and IT, these outcome-based services are perceived as more doable, therefore gaining more focus.

All our products are as relevant today as they were 20 years ago, however the technological aspects are growing. Here, I am talking about upgrading the equipment to meet the everlasting digitalisation of the world. What scared me a bit was that the electrical parts of our units stood for 3-5% in 1998, which today is more like 25%, thus being the most important part of the unit. [...] We have installed a digital manager in all our systems to grant us access to the unit. We can sit here in the office and run them, program the PLS, load and install new software, we can do close to everything. This was implemented as a standard from last year as a gesture to the customer, but also to gain more control and responsibility. Why should someone choose us as a provider? What does this mean for the customer? What is critical on an oilrig? Downtime is! Now we can provide digital troubleshooting for our units from our office, where the time to fix an issue could take just one hour, which took as much as two weeks a few years back. [...] The customer owns the product, but we own the PLS. This is about value creation in our company, where we must hold something back to gain some sort of dependency. The customer does not want to have an expert on PLS programming, as this is not their core business. – CEO, SPB

Two out of five are providing services as packets that could be purchased in addition to the product. The customers can select one out of a few predetermined service packages to different prices depending on its content. Here, the provider is trying to gain more responsibility and customer interactions through different services included in each package and seek to have the package be based on a fixed price over an agreed and contracted period. The subject of more customer interactions is intended to build loyalty and a relationship between the provider and

the customer, giving the provider insight into the customer's business as well as trying to prevent the customer to move over to competitors.

Basically, through these service packages we are able to bind or lock the customer to us for a short period of the lifecycle of the product. However, we are dependent on providing services with high quality for the customer to want us back next time. – VP Service, SC

It seemed to be a general understanding in the five case companies that the greatest potential in earnings are in the field of services. This was pointed out by the VP at SC when asked about their distribution of income from products and services.

Traditionally, new sales of new products stood for 70% of the income. This have gradually been evened out the last fifteen years due to changes in laws and regulations which lead to service activities to rise. When the new regulations were implemented, income from the service department have increased, where we now have a 55%:45% distribution from products and services. Product sales are still the largest, but earnings from services are higher as the margins compared to the activities it involves are greater. – VP Service, SC

In addition to services being perceived as more profitable, there is also a general agreement about how services are a more stable source of income. Every MC has been affected by the recent oil crisis where new sales have plummeted. Something all the participants agreed upon was that when the economy was good, production and new sales increased. And when the economy went down, so did production and sales. However, emphasis on services increased as the oil crisis struck.

- The service department has grown, and the production department has been reduced. This because of fewer contracts in the North Sea, and a downturn in the price of oil. We had thirty engineers, where we now only have ten. But this might have grown a bit this year as the price for oil has increased. VP Service, SC
- Per now, new sales stands for 70% of our income. However, our goal is to reach a 50:50 distribution because of the low stability in sales, where services appear to be a more stable source of income as well as increasing in demand. CEO, SPB

Both ITCs see a tendency that several industries are focusing more on providing services, from the automobile to provide cars on demand, to IT companies to offer digital services rather than selling servers. Products and services, as well as the production and development of such are



increasing in complexity, which also increases the need for competence and resources required for offering them.

We experience that more customers are wanting to move from selling products to providing services. For example, Volvo who have previously sold cars are now exploring the possibility of offering access to a car rather than have you buy one. If we look at IT companies, rather than selling you a server are now providing some sort of cloud service. [...] Regarding improving and optimising, we are looking at what can be automated. Now, the industry is a bit dejected about the emerging revolution in robotization. But I say that this robotization is something that has been ongoing for decades. We also see that production and products are increasing in complexity due to the installation of more sensors which are generating data to monitor and control the production. This results in where we previously had only mechanics to run the production and develop products, we now need mechanics, electricians, and someone who knows how to code. – Managing Consultant, ITCA

4.2 Culture and Human Resources

As this thesis does not include a high focus on the cultural aspect of digital servitization, the subject of human resources (HR) are included to widen the scope of this domain. By my interpretation, culture and HR could be acknowledged as related since younger personnel could play a vital role in cultural changes within digitalisation and digital transformation projects.

In general, every informant who was interviewed seem to have their customers in mind when talking about their products, services, and the future services they are planning to provide. When speaking of new services, the value proposition was often perceived as being on the customer's side as they always highlighted how these new and more complex services would be beneficial for the user regarding cost savings, efficiency, and effectiveness. This view of the customer may be a result of the insight the case companies are obtaining through the collection of data from several sources and closer interactions and relationships with parties in the value-chain, from suppliers to customers and possibly the end-user.

By getting more knowledgeable about the operational aspect of our system through data collection and build competence in operational processes such as logistics, drilling, and planning, we could provide more complex services with a focus of advising how these processes could be optimised. However, as the oil industry is quite conservative, it can take some time before the value of such services could be realised. – Chief Engineer, SPA



Another aspect that was highlighted in the larger companies (SPA and SC), was the issue of perception. Both companies were known as a production company in the 80s and 90s, and struggle to shake off this perception both internally and externally. The Chief Engineer from SPA talked about how both the media and their customers as well as some employees are still recognising them as an original equipment manufacturer (OEM), and not a solution provider. SPA have been working to change this perception through visual strategies for some time where SC are beginning to do the same with a new CEO in front.

For us, who are sitting in the office are experiencing that visions and strategies are not that visible throughout the organization. We do not have much of an insight in the strategic planning going on, but this is something the new CEO is working on. And by this, I mean to clarify and communicate a common vision and strategy. – Contract Coordinator, SC

Every MC express themselves as being more service-oriented now than what they were ten years ago where all argued an open-minded view is required to think new in a way that the value of complex services could be recognised and realised. Three out of five, in addition to one of the IT consultants argues this new way of thinking to be essential for the further evolvement and development of present and future services, especially in the case of digital services where everything could be possible. Though the MCs are more service-oriented, it seems that within this service-orientation lies a high focus on digital technologies and its role to improve and expand their service offerings.

- The department I worked in "New Services" did recently change name to "Digital Technologies". So yeah, digitalisation has been the main focus in a lot of the thing we have done over the past years, as well as for the things we are planning to do in the future. - Chief Engineer, SPA
- With today's technologies within IT and ICT, there are no limits to what is possible to accomplish. You can do whatever you want. It is not about liking it, but rather to follow the trends of the market. - CEO, SPB

With the increasing focus on thinking in new ways to develop complex digital services, new sets of skills, competence, and resources are required, as well as transforming the business both internally and externally to enable such developments. Regarding competence, two out of five have recently bought an IT company to obtain new and required competence where one of which, in addition to another, has entered into a partnership with IT consultants to develop digital strategies for guidance in terms of digital technologies. Every MC express an increasing



need for new and young personnel with fresh minds and digital knowledge where some also point out flexible employees as a requirement.

From the start, the main focus lied in production. With technical advancements and starting to think about rentals and services, we were in need of new competence, personnel who were willing to travel, and to educate and certify them for the new tasks at hand. For this type of business, you are required to have a flexible staff. There is no one who enjoys the production lines these days. The people I am looking for in this case are often of young age, let's say between twenty and forty years. They like the traveling, they enjoy that things happen, and get easily bored. If we look at rental and services where technicians travel globally, they attain experience and knowledge of the operational environment of the equipment. This information is highly valuable, as the experiences they bring back can be put into the production to improve the products even further. Additionally, as they gain a greater understanding of the operational part of the units within the processes of the user, the technicians are more knowledgeable of what is needed to provide the best possible product for a given customer. – CEO, SPB

It seems to be a general understanding that knowledge of the relationship between IT and business is required to drive digital transformation and exploit its benefits. Every main informant from each MC was perceived as knowledgeable in this relationship as they were often responsible for developing new digital initiatives and see to that the initiative was communicated and shared throughout the organization. One of the IT consultants expressed the need for leaders and managers to obtain knowledge of this relationship in a general example.

In larger organizations, the development and implementation of new IT initiatives takes time. A challenge presents itself between business and IT as business cannot keep waiting for IT to deliver a new service in one or two years when the market is demanding it next month. To have these two departments communicate with one another, and/or have some or someone in each department that understands the other, would be highly beneficial. And I would argue that the larger the organization is, the more challenging this becomes. – Managing Consultant, ITCA

The Managing Consultant at ITCA also spoke of involving both experienced and unexperienced employees in workshops to drive a cultural change. As an employee gets older and has been working in the same company for some time, they tend to acquire habits in ways of working and argue that their expertise is a basis for best practice. However, in a changing environment

where higher customer focus and digital technologies are altering or removing such practices, new practices appears where new mindsets, skills, and expertise will be required. It is essential to gain a common understanding of what is to be changed and why throughout the hierarchy of the organization.

The more expertise someone has in one area, the less open they may be for interactions with customers. With higher experience you might be less receptive for input on how things could be done. However, the newly hired and less experienced personnel tend to be more open for such dialogs. [...] When talking about cultural change, you do not have resources nor time to wait for the veterans to phase out and let the young people take over. If you want to change the culture, you must do so on every level at the same time with inputs from each level. When we are hired to digitalise a process, workshops are set up where the customers say that they will assemble personnel who have been working in this process for some time and often exclude the less experienced. I always ask them to bring along some of these younger people, and get something like: "Yeah, but he has only been working here for a few months and know nothing about how things are done here", where I reply: "Exactly!". This way we can question how these things are done as a set of fresh eyes are included. When hired in a company, you are often affected by the culture that is already there, thus adapting to it. Here it would be beneficial to have these young and fresh-minded people become ambassadors for the coming change. However, it is the leader's responsibility to share and communicate the upcoming changes. It is essential that the cultural change is manifested at the highest level, but it is just as important throughout the different levels of the organization. The leaders must convey and explain why, managers and middle-men must transfer this to their processes, and it will have to be some passionate souls on the floor who actually implement and practice it. If you acquire a selected few who are willing to change, the new practices can be tested for real, thus neutralising the tension associated with the change which results in more people wanting to get involved. – Managing Consultant, ITCA

It is evident that every MC is focusing on communication and sharing of knowledge with transparency, continuous improvement, and the customers in mind. By transparency, they are meaning to break down the barriers associated with a silo mentality where information and knowledge is not shared throughout the organization. Continuous improvement is enabled as departments and partners are becoming united by helping and advising one another on how things could be improved from more than one point of view. By doing so, a common



understanding of the products and services and their value is shared, which could help provide and develop the best solutions for the customers through collaboration with the purpose of reaching a common goal.

The process of collecting data from the outside and use it internally might not be as formalised as we want. This is regarding our own service technicians as well as our partners. We do gain a lot of information about our products from external sources, which could be of value for production and development to acquire. There is much that looks good on paper, but the physical execution might not be as doable as the papers are indicating. We are however working on ways for experiences gained by external personnel and partners in the field to be communicated back to us. [...] Our culture has traditionally revolved around each department working individually, where we have little insight into what the other departments are doing. Production have produced something and has no idea where the product is going or who the customer is. [...] There has been a silo mentality due to this being the way we always have been operating. Now we see that this kind of mentality appears as a problem and a challenge, which is something our new CEO is trying to change. It is clear that if we could achieve collaboration and share information with every department, knowledge and of course pride from what is done within services could be spread and shared throughout the organization, as well as the other way around. - Contract Coordinator, SC

4.3 Structure

Within the subject of organizational structure in digital servitization, changes in this area was experienced as difficult to identify as every informant expressed structural change to be of less importance. There were no significant findings in this domain as there were no explicit new departments or major changes occurring in the structure. However, some informants, especially one IT consultant discussed some structural aspects that could be of relevance to this research.

With an increasing focus on services and IT, two case companies have recently added new departments. As mentioned, SPA have altered the focus of the department which originally aimed to develop new services, to focus more on the opportunities and possibilities within digital technologies in present and future services. Whereas the Operations Director at SPC speak of their new department of Business Development which aims to further develop and improve their business by utilising digital technologies for data generation, collection, and use. The intention of this is to improve and automate internal processes; enabling new and more

complex services to be developed. Every MC express that their departments associated with developing new services and execute and manage present ones are continuously expanding.

We are working on ways that our products can be remotely controlled and potentially autonomous. It is clear, that these more capable and highly advanced products are superior to the ones we are providing today, where the new ones will bring a completely new aspect to our business. This will require us to obtain new and completely different people who can operate and run it. And with controlling, it might be that we get a whole staff placed on the second floor here working with monitoring and controlling them. This is of course something we do not have, but we will in the future. – VP Service, SC

As products and services are increasing in complexity due to the escalating implementation of elements and methods from IT, more know-how and competence is perceived as a requirement. As mentioned, two of the more digitally matured companies have gained access to such competence by buying an IT company and including them in their organization. The CEO of SPB explained how there were a few reasons for such an acquisition. Firstly, due to the everlasting digitalisation of the world, they were in need of competence in this field as the electrical- and IT aspect of the products were increasing. And secondly, by having this competence inhouse they could enable the possibility of sharing knowledge and work together to better improve the processes, thus strengthening the value of this area.

We are trying to work with the same suppliers to enable collaboration where we find solutions and optimise the product range together. Here, the big challenge was associated with the electrical part of the units. Over the years, the units have become more electrical-and computer-based. Previously, where a supplier in this area came to perform some electrical or digital installation on our units, they performed the installation once, set a price and thus getting paid. We have always desired to possess ownership of this process. When the supplier has performed such an installation, they get contracted to perform an identical operation next time. We are longing for our suppliers to invest in our product by having dedicated people evaluate the installation and come with recommendations on how to potentially optimise the process for later installations. We wish to collaborate to improve our products and reduce costs as we are competing on a global scale, which is not easy with the expensiveness of being a Norwegian-registered company. What we had to do for this collaboration and continuous improvement to become possible, was to buy this supplier thus secured ownership of the knowledge in programming, software,



ownership of the PLS, and licenses in these areas. As the electrical component became the major element of our units, we bought the most critical part. – CEO, SPB

In addition to the increasing need for more competence as the products and services are becoming more complex, the notion of cross-functional teams in development is highlighted. With higher complexity comes the need for communicating information and knowledge from several perspectives to enable more complex issues to be solved.

The different departments have traditionally been operating on their own, where there have been some barriers of fog between them. But for the last year, we are demanding crossfunctional teams to work together when new projects or developments are initiated. – Contract Coordinator, SC

There is a common agreement that silo mentality acts as a hindrance for the further development and realisation of new and complex digital services. Every MC has been and/or are working on breaking down the barriers associated with silos to enable transparency and openness throughout the organization. This is pursued by having the different departments connected through methods of communication often residing in digital tools for collecting, sharing, and displaying information.

We are working on a digitalisation project to have each department work more digitally. Where we previously have done much of the work manually with checklists and physical drawings, digital tools and methods will be used instead. Service technicians are going to have their checklists conducted on tablets, design and development will perform their designs and drawing in digital tools, and production are becoming more digitised as well. By having all this information collected within a single digital system, everyone should be able to access the information they need, and when they need it, through a computer. – Contract Coordinator, SC

Regarding the subject of a higher customer focus, one IT consultant is observing that larger parts of organizations are interfering directly with customers by having a greater share of the staff associating themselves with the end-user. He experiences that the barrier between frontend and back-end offices are being increasingly bridged. Additionally, there is a tendency for these organizations to cut some links in the value-chain to enable closer and more direct interactions with the customers.

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What we see some companies are doing, is that they are wanting to gain more control over the value-chain. These companies are increasingly wishing to own a personal relationship with the customer. To obtain direct contact with customers, they often cut some sections of the value-chain. This might alter some parts of the organizational structure and how they are organised as more and more departments, and a larger part of the internal organization are associating themselves with the external customer. These days, customer contact is not necessarily limited to customer support or the ones who acts as a physical point of contact with the customers. If you are going to sell directly to the customer, you will need to relate to them. Here, you have to a greater extent own the customer relationship, compared to be some middleman. It is important to know which processes that must be set as a foundation for you to move closer to the customer, thus allowing you to do it yourself. To avoid valuable information getting lost in the valuechain, we see that organizations are either implementing advanced methods for gathering data or reducing sections in the chain, thus gaining closer relations to customers. This enables feedback and complaints to be better evaluated and can be used to for example improve the next generation of a product with the user in mind. – Managing Consultant, ITCA

4.4 Network

With higher focus on services and customers, organizations are attempting to break down the internal barriers of silos through openness and transparency. For a higher service-orientation to be successful, the focus on sharing knowledge and information is also highlighted for the external relations and environment in which the organizations are operating. There does not seem to be any major changes in the value-chains of the case companies, though some aspects within network appear to be of relevance.

As products and services are increasing in complexity due to the increasing embedding of IT, the value-chain tend to widen as new actors in this field are included. The MCs which have or are planning to increase complexity in their offerings with IT, discuss how companies with competence in this area are getting a more vital role in the value-chain. It is a continuous process for deciding if the companies are to make or buy competence within IT where one consultant argue that there is a trend of outsourcing some aspects of IT. However, in SPB where IT has become the most critical component of their units, it was decided to obtain this competence



through an acquisition. Where organizations have traditionally thought of bringing more competence inhouse, there seems to be a higher focus on partnership these days.

- There is always the question if whether to do something ourselves or to have someone else do it for us. This is a continuous process. It is not granted that you are the best if you are to do everything yourself. – CEO, SPB
- Traditionally, we were probably more focused on owning the external service stations. But because things are happening at an increasing rate, there has been a higher focus on getting partners to perform services to cover the growing demand. I would argue that we wish to own as much as possible to have more value within the company, but there are some locations in different continents where opening a new office will be more difficult and costly than acquiring a service partner. – Contract Coordinator, SC

Every MC is expressing that they are increasing their interest of partnerships with external suppliers and service providers. As these highly complex digital services are requiring new ways of thinking and inputs from several sources, the subject of collaborative partnerships is seen as essential to enable continuous improvement in development and delivery of such offerings.

- I would argue that networking is important for the more complex services. It is obvious that you gain more and other types of input, where you are dependent on having people around you as you are in a never-ending change. It will be quite difficult to keep track of and orient yourself about all the changes and demands coming your way. Here, it is important to have a wide network of competence which can be used for your advantage by saying "you are good at this, and we are good at this other thing", thus complementing each other. – Managing Consultant, ITCA
- There are some cases where a cheaper supplier has been discovered, and we choose not to pursue them due to the good relation we have with the supplier of the same component. This was the case for our supplier of an "electrical box", where our relationship is more valuable than a lower price as they give us input and advice on how to improve our units regarding this box. This is the relationships we want, and as a goal we seek to gain this kind of relations with all our suppliers. This is based on openness where we allow failure, inform the other parties of the errors and work together to reach a common goal, where the goal should be the best possible solution for the customer. – Product Manager, EC

With a network of partners in which every party is focusing on developing and deploying the best service for the customer, emphasis on the ecosystem is highlighted. It seems to be crucial to gain an understanding of the whole ecosystem and define your role within this system, especially when complex digital services and its data is at the centre.

When speaking of the cultural changes of opening silos, I would say that an increasing number of people are gaining an understanding that something had to happen in this regard. We have in our technical strategy focused on looking at the ecosystem and define our role in this system. We must understand the whole system, the logistics, the flow of data, our roles, what potential services we can provide, how far we are going to be responsible for the data, and thus understanding our role. You must acknowledge the whole system, no matter what is yours and not yours. You need to understand the ecosystem to know where you can enter with your services, and to know where you can earn money. – Chief Engineer, SPA

By emphasising on the ecosystem and partnerships with different actors in the value-chain, it seems that the MCs are focusing more on opening up for sharing information, knowledge, and competence with external parties. The notion of transparency is not limited to internal openness, but also to have the whole network become transparent. This will require every actor in the ecosystem to share the acknowledged importance of openness to prevent undesirable cases of dependency and opportunism. It is also highlighted how openness in the network allows for insight into each other's companies and operations, which is perceived as highly valuable.

There was recently a customer who expressed the reasons for choosing us as partners. They said that they had conducted a thorough evaluation and concluded that a partnership was favourable in order to achieve a relationship where we would obtain a higher understanding of what they were doing, thus enabling us to assist with better consulting specifically aimed at them. [...] If you have been supplying someone for a long time, you will gain a greater understanding and insight into their everyday operations. What we often do in a value stream analysis, is to explain to the customer the value of including your suppliers. [...] If one knows how the internal processes of an organization looks, it is easier for suppliers to adjust and adapt to this. We often observe that there is a tendency for silo mentality toward external sources, where people perceive internal personnel as the ones you can talk to, but external ones are not to be communicated with in the same manner. [...] On the other hand, it could be that a too close relationship with customers and suppliers could present unfortunate situations such as corruption and dependency.



So yeah, there are cons with close relations as well, where you will have to find some sort of balance. It is important that both parties have an attitude of "if we are doing well, so will you, and vice versa". – Managing Consultant, ITCA

The larger and more resourceful organizations are often attempting to gain control of their value-chain through acquisitions which enables transparency and collaboration in their ecosystem. As the smaller organizations do not possess the resources or capabilities to do the same, there is an increasing interest in developing a network of competence as a shared digital platform where every collaborative actor in the ecosystem can insert and extract data, knowledge, and experiences. By establishing such a platform, a pool of competence can be gathered and utilised as suppliers, customers, research communities, and users are included. The Chief Engineer of SPA argues this to be a method on the rise and will in the future be implemented in several industries. However, he explains that there is a missing actor within this field who can help organizations make use of such platforms.

- We observe that more organizations are wanting to develop a network of competence, where a shared platform is established for users, customers, and suppliers to enter digital dialogs and share knowledge. This is an example of how networking may affect future offerings. – Managing Consultant, ITCA
- By collaborating and sharing information, I would argue that the oil industry could experience a tremendous boost in productivity. Unfortunately, silos and business models in the industry are currently acting as a hindrance. There has been a case where a service company earned more cash by hanging up additional equipment with sensors on the oilrigs, where we already had these sensors deployed. To prevent duplicates, these service companies who were in need of instrumentation and data came to us and asked for access to this information, which lead to a more digital communication. But businesswise, there is a lot that can be done more efficiently, and it is here we see that the gigantic companies are buying the whole value-chain to enable them to provide complete and complex services. They have acknowledged that if you are able to optimise processes and remove silos, you are more capable of offering a complete system with optimal efficiency. Us, on the other hand, are not big enough to do the same. We rather focus on openness for sharing and gaining data. If we can receive data, we can be more capable of offering services as specialists, as well as granting other and maybe small companies the ability of tapping into this data to offer us advice. This has been going on in the IT industry and open source communities for several years, which is a perfect example of the benefits in



openness and sharing. I am convinced that this is the way our industry is moving. But as we do not possess the resources of the big players, I believe that being open is our best alternative to have several companies come up with more good ideas, but then have this be in a collaborative way rather than have all services be in a huge organization through acquisitions of the value-chain. I rather believe in this open solution by inviting several parties. [...] We have just recently agreed to supply a research community with a complete drilling simulator which we use in our projects. Here, they are establishing a so called OpenLab with this simulator to be used in education and research, and to invite others to conduct analysis where the results could be of value for us. [...] We have seen that suppliers of platforms are flourishing lately. Platforms for collecting and organising data in a way that the data can be accessible. There are huge amounts of data which can be of value, where most of it gets absorbed in the oil companies which prevents us from gaining insight and knowledge of the operations going on. It is all about combining all the data and make use of it these days, where suppliers of such platforms are perceived as new actors in the industry. However, there is a lack of actors who can make use of all this data by utilising new and advanced types of technology such as AI, neural networks, and all sorts of tools that can be placed upon these platforms. – Chief Engineer, SPA

4.5 Processes, Capabilities, and Data

The subject of processes and capabilities revolves mostly around the subject of digitalisation due to organizations improving their internal and external processes and capabilities with the help of digital technologies. This seems to be a prerequisite for the delivery of complex digital services as such services relies heavily on real-time data from several sources. It seems that a mindset of continuous improvement of processes and capabilities is present in every MC where they acknowledge efficient and automated processes being essential for new and complex offerings in the future.

Every case company are focusing on improving their internal processes through digitalisation of manual and non-value adding work. Their intentions for this are plentiful where the major ones are highlighted as to reduce the need for a larger staff in the troublesome time of the recent oil crisis, remove the bottlenecks in production and delivery for greater capabilities, release time for employees to be used elsewhere, and to enable flexibility extensively. The CEO of SPB talks about the market in the oil industry and expresses the need for a stable yet flexible production. He argues that you will have to be flexible to meet the demands of a fluctuating



market, but at the same time attain a stable production to prevent temporary and permanent layoffs.

The industry has been changing lately. The larger oil companies with tens of thousands of employees who previously both built and maintained their equipment have begun to realise that their size acts as a hindrance to keep up with the changes in the market. They were too big and too bureaucratic to keep up, thus outsourcing the production to companies like ours. We are small, flexible, implement changes faster, and of course at a cheaper price. They would never be able to compete with this. Rentals and services have occurred on its own due to the continuous optimisation of production and the product itself. Especially when the electrical element of the units grew as well as the increasing focus on core competence, these larger companies sought to let us deal with them. [...] The more we produced of existing orders, the operating income and profits were invested in components to build rentals. After two years, the first rental was completed and rented to a customer. In this market you will never attain a 100% stable production over a annual period where the production will vary. How could I optimise the personnel in such a market? I could not fire them or have them temporary laid off at every downturn. When I decided to build rentals, the downturns between production of units to be sold were used to build rentals. As mentioned the time to produce a unit could take up to seven months, but for the rentals, it could take up to a year or even more. This optimised the personnel and filled out the production. The market is fluctuating, which force you to think new and to figure out how to attain a stable production, a stable staff, and a stable income. There is no one who will work for you if you keep laying them off at every downturn. [...] We are constantly evolving, and I would argue if we stop to evolve and say that we can provide the optimal product, we will go out of business within a year. There is always room for improvements, and this is the main reason why our mechanics and technicians need to report back what is good and what is bad. – CEO, SPB

The notion of layoffs is known to be of high concern with employees when processes and manual work are being automated and optimised. The Managing Consultant at ITCA express the importance of a big picture understanding of the whole organization and its processes when automating through digitalisation. The goal of digitalisation projects should not be to remove the need for people, but to automate repetitive, boring, and manual non-value adding operations. This may release valuable time for employees which can be used for other purposes such as participating in improvement projects and build more competence.

We often experience that if you optimise a bottleneck, it can affect some other processes which then becomes the new bottleneck. When digitalising and automating processes, it is important to have a holistic perspective to acknowledge the causes and effects of the change. [...] In one case where we automated a transaction process, the employees responsible for this process were put to rather manage deviations which was less demanding than the previous work. As a result, they would spend half an hour every day with the focus on improvement. They could review initiatives for improvements or use the extra time to gain more competence through courses and certifications. Organizations will not save that much on firing people in such projects, and I discourage them to do so as competence and tacit knowledge could get lost. [...] I believe that many of these automations going on will result in operations and work to alternate, and that people will then work differently and on other tasks. Today, there are many who are good at analysing vast amounts of data manually, where their competence and insight could be useful in other aspects. I do think that many jobs will disappear, but new ones will emerge. If there is something that history has taught us, these kinds of changes will occur either you want it or not. It is best to evolve in parallel to the changes taking place. – Managing Consultant, ITCA

As customers are demanding more complex services, the case companies are focusing on having more sensors and areas in which data could be generated and collected. Data in realtime from every relevant and possible source will be of importance for digital services to become feasible. Two out of five case companies express the need for a highly capable digital infrastructure with sensors throughout the value-chain for their more complex services to be doable. Customers are wanting instant, precise, and updated information and documentation of products and services where the two MCs have been developing a web-based portal for customers and suppliers to access. These digital portals are used as a channel for information where relevant documentation and information about a product can be extracted, as well as enabling customers and suppliers to provide feedback on a specific product.

We have been trying to develop a service where we can give advice on how operations can be optimised. This is the intention of our portal solution. Firstly, this portal functions as an online store for our products, but also a way of communicating with the customers to make sure that they get all the documentations necessary for the equipment. Secondly, they can give feedback on errors and issues, thus working as a channel for sharing information. [...] In today's society, you are dependent on having data in real-time to be



able to offer services that a customer is content with. The stock price in the newspaper the day after does not apply, which is also the case for our services. There is therefore a high focus on the offerings we are to provide to be based on data in real-time, where a capable digital infrastructure will be a necessity. – Chief Engineer, SPA

The Chief Engineer at SPA also speaks of the increasing interest in cloud-based services. When their solution for a portal was implemented, there were some security concerns about hosting this in a cloud. However, with the evolvement in this area he expressed that cloud-based solutions are of higher value now than what they were back then.

We were a bit unfortunate when we chose to host this portal locally due to security concerns and scepticism surrounding the cloud. By having this in-house, the operational aspect of this solution seems to be more expensive as a cloud-based solution today would be cheaper. – Chief Engineer, SPA

With more sources for collecting data, the Operations Director at SPC talked about how the internal processes from ordering to delivery can be monitored and improved. If data from orders, production, and delivery is collected in a single system, the data can function as an input to the ERP system and their portal and updating them automatically. Data from a product could help provide service technicians with information of what parts and tools to bring, which will improve the first-time fix rates and prevent unfortunate and unforeseen work and costs associated with it.

We do not wish to man up and hire more people now that there has been an increase in sales and turnover. We are focusing more on automating and optimising the bottlenecks due to this growth, where we have identified the ordering process as one of the larger ones. There is no value in opening documents from orders to update dates and quantities of whatever in the ERP system. The data is however of value as it is used to inform the customers and is also of value in production as it helps them plan ahead. There is no point in beginning work you cannot complete. [...] In the future, we wish to have sensors within the products that can give us insightful information about what is going on, which can help our technicians bring the correct tools and parts. – Operations Director, SPC

The method SPC are working on to enable this way of automating the ordering process, is to have the major orders run through EHFs. EHF is an electronic invoice with all sorts of information included. They seek to use EHFs as invoices, order confirmations, offers, and purchase orders. By having the computer deal with this information, and connect this to their

portal as well as their ERP, vast amounts of manual work can become automated, highly optimised, and reduces the chances of inaccuracy.

Previously, invoices were printed and put in an envelope. We are now looking at the possibilities with EHF, which is even better than PDFs as the exchange of data between systems are instant with EHFs, whereas the systems must interpret the information from PDFs where it is room for errors to occur. [...] We do not wish to limit EHFs to invoices, but also use it for order confirmations, offers, and purchasing orders. This way we save a lot of time and reduce errors by not having to generate PDFs, make emails, send them, and memo them. – Operations Director, SPC

Two out of five express the difficulties in selling and addressing the value of services. SC who are new to the service sector imply that their sales personnel are focusing more on selling a product than a service where the sellers would have to be educated about the services to be more capable of addressing their potential value for the buyers. The Chief Engineer at SPA also speaks of the difficulties in selling complex digital services regarding operations where data from the system in use are meant to bring value to the customer over time.

- We have observed that there is a great potential in collecting data from the system in use. This is regarding the logistics and operational aspects of our system, where we want to use the gathered data to offer new kinds of services and provide consulting on how the operations, logistics, and planning surrounding this can be improved. [...] When we are testing new software, we use a digital twin. We would rather have an oilrig disposable for such testing but will have to suffice with the virtual. We bought a company who specialises in digital twins and began to think of what kinds of services we could develop around this. But we experience this service as being hard to sell as the industry might not yet see its potential. We saw that our customers meant it was our responsibility to fully test the service before selling it to them. But we are in need of data in use to have this perfected, which is difficult due to business models in the industry. – Chief Engineer, SPA
- It can be difficult for the customer to grasp the value of a given service, and to understand what problems this service could potentially solve. It is all about how sellers and promoters communicate outward to help the customer understand the value of what the service can assist with. – Managing Consultant, ITCA

Another issue within services are pointed out and revolves around the pricing of the services. As SPA and SC are providing service packages to fixed prices, it is hard to determine the correct



price for it to become profitable at the same time attractive for customers. When asked how they had these services priced, they both replied, "an educated guess". They use historical data from similar sold systems and products and conclude with an average. However, they see that there are more data that could be used in this regard as the products and services are becoming more digitally complex.

- We guess. We look at the historical data of equipment sold, where we have conducted calculations on averages related to the specific type of oilrig, how much the rig has been operational, look at the history of maintenance, repair, and spare parts of this rig, and then get to an educated guess of a price. But since this is new for us, we have sought to agree with customers that some adjustments can be made later on, where they appreciate this agreement as it is new to them as well. – Chief Engineer, SPA
- Well, it is kind of an educated guess, but revolves around three aspects. Those are the age of the customers ship, its operational location, and the number of hours our products have been used which is information that we gather in an evaluation. [...] We perform over a thousand services every year, which helps us identify the costs of such services. In addition to these references, we performed services on every single product we deliver according to our guidelines. We timed this and compared it to actual cases, where we concluded with some estimates. – VP Service, SC
- What we often see the electricity provider do when attempting to set fixed prices for services, is to estimate an annual use with the use of historical data. The more you know about the customer and their habits, the more capable you are in predicting these prices. -Managing Consultant, ITCA

4.6 Digital Technologies

Though many of the digital technologies the MCs are benefiting from has been mentioned above, some technologies and aspects in which they are relevant are yet to be presented. As the case companies are perceived as moderate and more digitally matured, they are all focusing intensively on the potential benefits of digital technologies. Not only to digitalise and optimise processes to facilitate complex digital services, the digital is also explored to recognise and realise the services of the future.

As the MCs are implementing more sources of gathering data through communication, internal and external sensors, and with digital processes in every department, the amounts of data

generated are tremendous. They all agree that the notion of big data is or will be of high importance where competence in structuring and making sense of the data will be required.

We see that more organizations are wanting to gather data about their customers, and their products and services in use. Everybody is talking about big data these days. Without saying that this is a trend, we do observe that the today's need for IT competence are moving away from traditional server operations to demand more competence in databases and platforms which can be used for structuring and make use of vast amounts of collected data. – Managing Consultant, ITCA

The intention of such platforms is described by the Chief Engineer at SPA as to have their competence and knowledge of the industry and operations in oil to be combined with IT's knowledge and competence of digital technologies and data. By combining these two, he claims that this is where the "magic will happen". As the domains of drilling and IT are highly complex, SPA seek to collaborate with IT companies due to the demanding process of building competence in the unknown domain, which will also be the case for IT companies concerning the competence in drilling.

We are in need of an IT partner of a certain size to achieve our plans for the future, instead of establishing a large department that can build up the required competence in IT. We would rather acquire a collaborator and invite them to come up with solutions for the problems we are presenting. We are looking for someone who can make use of the data we are collecting for these platforms. It is all about our competence in drilling, combined with competence in IT, as this is where the magic will happen. If you base your IT company on the utilisation of digital technologies, what is really the value and what would be useful to know? Here they would struggle for years to build a company which are going to be knowledgeable of the processes in drilling, due to this being extremely complex. – Chief Engineer, SPA

With data being generated from several sources and transmitted to such platforms or large databases, some concerns about security rises. Though the Chief Engineer at SPA argues the databases in which all this data is to be collected would not be interpretable unless you know what you are looking at, there is always room for inaccuracy and manipulation of the data. The Operations Director at SPC speak of how blockchain technologies behind cryptocurrency may help validate and secure the vast amounts of data transmitted.



In addition to how the data can be secured, SPC also look at the possibilities within AI to optimise processes in production, procurement, and delivery. In the processes of production and procurement, the AI is meant to be connected to the EHFs and ERP system to secure quality in production and simplify and automate the process of procurement. Regarding delivery, the AI will provide faster and more accurate responses to customers as a part of their service.

With all the products we have and all their compositions and requirements, there are some combinations which are not to be assembled. Here we wish to use machine learning to make sure the integrity of what is combined is correct. This is about identifying faults before they are ever produced. We also wish to use machine learning to avoid our sales people having to interpret the customer's demands manually, and have the machine base its decisions on technical specifications, history, and combination of products. We are trying to have our competence inserted into a machine and learn it to use this competence in a much faster and accurate way than what humans are capable of. If we look a bit further regarding IoT and machine learning, it is meant to provide our customers with quicker responses as part of our services. Everything we are doing these days is to improve the quality and efficiency of our services. An example of this is in orders and procurement. Let's say we get a list of 2.200 items with identifications and descriptions, it could take weeks to interpret what this is. We wish to cut this down to a few days, if not hours. This, by itself could be a service we could provide. What we are actually looking at is a portal in which customers and suppliers can access to find answers faster both regarding what is needed and what is to be produced. From the suppliers' perspective, it could help them know what to produce as they can see that we will soon make a purchase, based on orders we get or maximum and minimum levels in our warehouses. – Operations Director, SPC

Regarding IoT and more advanced digital technologies, SPA have been exploring the potential of digital twins. A digital twin is a virtual representation of the complete system they are providing where every system produced could be linked with their digital twin. SPA is looking at the possibilities of what kind of services that could be provided with the use of the virtual

and seek to have future services be based on it. The digital twin may function as a way of moving the oil industry from calendar-based maintenance to become more based on condition, which is what both SPA and SPC are seeking to do with the help of sensors and other methods for generating and utilising data.

The reason for using digital twins is to monitor what is happening, why they happen, and what is to be done if it happens, mostly regarding maintenance and repairs. This might not be the only reason as the data can be used for countless things such as improvement projects and analysis. This way you can sit either on shore or offshore in front of a screen and see how for example an oilrig is pumping oil, the power consumption, and other values like temperature and pressure. Here you can sit and analyse this in a digital twin and have all kinds of information about what happened before a given event occurred. This is the direction the oil industry is taking regarding digitalisation. With all this data you enable preventive maintenance, where you can anticipate failure and fix the problem before it ever happens. The industry might have been working towards this for some time, but technology and sensors are allowing this on a totally different way by working in larger models than previously. This way, an operator on the rig could through a handheld device access this information and perform his job exceptionally. Everything he does will be communicated back to operations on shore which is monitoring this rig virtually, where such a service would remove the need for operations to be offshore. AI and AR could also be used in this manner to guide the operator on an offshore repair assignment to walk the shortest routes and perform the correct repairs without getting lost. -Associate Director, ITCB

Several years ago, SPA did an experiment with cameras onboard oilrigs for the same purposes as AR could be used for guiding operators. These cameras were extremely expensive due to the add-ons and capsules needed for making them explosion-proof. The experience from use of cameras is something SPA are bringing back as the future in AR is on the rise now that the equipment in this regard are getting cheaper, smaller, and more wearable. Additionally, the capability and coverage of both wired and wireless connections are increasing, which may function as a driver for the implementation of AR.

We were early in utilising cameras to guide service technicians who went offshore. What we today refer to as AR was something we were experimenting with fifteen years ago and is now being brought back. These cameras were quite heavy and could cost as much as 150,000 NOK each. Now, the equipment is becoming smaller, cheaper, and more



wearable, even in explosion-poof and hazardous areas. The speed of digital communication is increasing, wireless coverage on the oilrigs are more developed, which enables new possibilities. This is also regarding 4G and 5G that can facilitate and drive such services. – Chief Engineer, SPA

As SPA is collecting data from distant oilrigs, a strong and capable digital infrastructure is needed to transmit this data with required accuracy and speed. Some rigs are being connected to the mainland through fibre optic wires, which enables large amounts of data to be transmitted. However, there are some rigs that do not have the same connection where a satellite link is used instead. These links are slower and costlier than fibre optics where a method of edge computing is used to limit the data being transmitted, therefore only obtaining useful information rather than transmitting all the raw data.

When it comes to transmitting data, we have been focusing on utilising edge computing so that we do not have to gather all the raw data. Think of a vibration measurement that measures with 50 kHz, that is 50,000 times a second. If you were to transmit all of this data to a central storage, it would be an awful lot of data. But there are ways that analysis of the measurements could be performed locally, where only the results of the analysis or the relevant measurements are transmitted back to us. A lot has happened regarding edge computing which enables us to get online real-time analysis and send only small chucks of data at the time. If you are smart, you could permit this on a relatively slow bitrate over a satellite link. – Chief Engineer, SPA

4.7 Operational Environment and Market

Both industries of maritime and oil are perceived as highly conservative where every MC express their concerns of how conservative markets prohibit the further development and realisation of more complex services. Some of these concerns revolves around how the market is increasingly demanding customised and instantaneous responses and services where data in real-time will be necessary for providing this. However, conservative markets with their business models and silo mentality acts as barriers for such offerings to be perfected.

The Chief Engineer at SPA talks about how the business models in the oil industry is destructive in how complex services could make the industry more efficient. These business models are destructive because owners and operators of oilrigs do not benefit from the operations to be optimised where optimisation of processes would lead to less income for one or both parties.

If we look at the business models in the oil industry, there is something quite strange and you will have to be aware of this. Depending if the rig is floating or fixed, there are different models that apply. If the rig is fixed, the rig is mostly owned by the oil company where they also own the equipment onboard. In this case, the business model implies that the oil company cannot operate it themselves. Here, we are in a strange position as we could provide services to increase the efficiency which became a subject of discussion as an increased efficiency would also increase the need for maintenance, where maintenance was something the operator got payed at a fixed rate. This way, the operators would have to do more maintenance, but lose money in the process. Therefore, the companies who are operating fixed rigs do not want to increase their efficiency, and I argue this to be destructive for the industry. It is a bit different when the oil companies are renting a rig that floats where they do not have any ownership of the rig. Nor are they interested in improving efficiency as they get payed on a daily basis. If they got a hundred days to drill a well, they would get payed for hundred days. If we, as provider of equipment and services could help them drill this in eighty days, they would lose twenty days of this daily rate. Another aspect that is destructive, is that the oil companies are the ones who pay for the fuel and power consumption on these floating rigs. This way, the operators do not focus on how much fuel and power is being consumed, as they are not the ones paying for it. [...] These business models do not facilitate that being more efficient is beneficial. However, this has been changing a bit lately, and larger changes are yet to come. [...] I would argue that every party could profit more if they were critical to these models, and made way for new technology, new products, and new services. [...] I believe that is not difficult to come up with new techniques and methods for this industry, due to it being so conservative. Even well-established methods in other industries could be of use here. – Chief Engineer, SPA

In addition to the business models acting as barriers for improved efficiency, they have been hindering collaboration and communication between the parties involved. This has however gotten better over the years, where oil companies, operators, suppliers, and service providers are beginning to realise that communication is key for improvements.

Regarding business models, processing and altering a conservative industry takes time. It is all about the time of processing. You need to process your customers, and they have to process their customers, where we observe a lack in collaboration which might have gotten a bit better after the crisis. If we look at the collaboration between the operators,



for example Equinor, a company that they are renting a rig from, and us. Here, it has been in such a way that Equinor communicates with the rig owner, and the rig owner communicates with us if we were the supplier. What we see, is that the operators are the ones setting the premises for the rigs they are renting. We have tried to open dialogs with the operators to tell them what is possible and what demands could be made to the rig owners. But we have to be careful that our customers do not get upset with us because of something we told the operators. We are trying to bring all these three together. On the side, there are also some service companies that traditionally have been analysing what is going on in the well, where we also want to bring them along. If you could gather all these four key players to communicate and collaborate, you could get a tremendous growth in efficiency in the industry. – Chief Engineer, SPA

Another aspect of the industry being conservative, which is also the case for maritime, is the imposed calendar-based maintenances which follows a so called five-year classification. As both the oil and maritime industries are meant to follow these classifications, it is hard to sell condition-based maintenance services where alterations in laws and business models are required to enable maintenance and other services be more based on the condition of the equipment. It seems to be a general agreement in the case companies that condition-based maintenance could help companies improve their efficiency and save great amounts of money.

Our customers normally say that every hose on their rig should be changed every fifth year. This means that they are throwing away a whole bunch of "unused" hoses which could have been used five to ten more years, just because they do not want to risk downtime. If you could apply sensors to generate data, and predict when a hose would fail, you could help the customer keep as much as 80% of their hoses for a longer period. There is a lot of money to be saved here! [...] We see that such predictive services could help the customer save as much as eight to ten million NOK in hoses, and to prevent the need for the rig to get transported to the mainland. There are of course not only hoses that get replaced at such trips, though it would be easier to plan for when the rig will be out of service as you have a better overview. – Operations Director, SPC

Regarding sensors, though these are perceived as cheap in general, they could be quite expensive in hazardous environments. Previously, sensors would have to be connected through wires to secure data to be transmitted error-free. These sensors are now becoming more wireless, which will according to the Chief Engineer at SPA be a huge step forward for the oil

industry. As some ships are also concerned with explosion-proofing, this would also be relevant for the maritime industry.

It is evident that IoT and more intelligent sensors could perform analysis more automatically and error-free. As in all other industries, this will probably become essential for ours as well. The issue with sensors in hazardous environments is their expensiveness. In a nonhazardous factory, such sensors could cost \$1, where they could cost as much as \$10,000 offshore. What is about to happen, is that the wireless sensors are becoming more developed regarding safety and capacity. Especially in oil, it is important that the data gets transmitted and free of errors, where cables were often used to ensure this as wireless was not that reliable. If a sensor cost as much as mentioned, the cables would be equally expensive. Even worse, if something went wrong and had to be troubleshooted, there were so many cables and areas that had to be evaluated. If we could replace this with reasonable wireless sensors, we would reduce the costs of installations as well as simplifying the troubleshooting process. We are dependent on research and further development of wireless sensors in hazardous environments with a battery life of five or more years. This will revolutionise the industry! – Chief Engineer, SPA

For case companies to advance in providing services, they are longing for some disruptive changes in the industries. With both industries being conservative, they do not see this as something that will happen in the near future. However, with the advancements of digital technologies and IoT, they are hoping for some alterations in the environment which will be beneficial for the providers of services.

Unfortunately, there have not been that much of disruptive changes in our industry. I do however hope for some changes to occur, for example in the way of providing services. We are always trying to be one step ahead, though there have not been much disruptive changes, yet. The oil industry is extremely conservative and might be one of the most conservative industries of them all. [...] This might change as digitalisation and IoT are gaining momentum. We see that even the largest companies, with their digitalisation strategies do not even know what comes of this, or what they can do with it. [...] If you look at the larger organizations, like Equinor and Aker BP, they are spending enormous amounts of money to try and change the oil industry. So, it may be that this time, some disruptive changes may occur. Let us hope so. – Operations Director, SPC



4.8 Laws and Authorities

The final domain that was perceived as relevant is the subject of laws and regulations governed by authorities. As mentioned in the previous domain, legislations force the maritime and oil industries to conduct five-year classifications which prohibit the further development and delivery of condition-based services as these services would not be beneficial if these regulations do not alter. Another aspect of this is the issue surrounding ownership and management of data. This has however been brought up for discussion lately, where the Norwegian government implement platforms for regulating data in certain industries and the European Union (EU) have just implemented the General Data Protection Regulation (GDPR) for accommodating the issue of owning and managing data.

Three out of five MCs, as well as both consultants express their concern about how legislation of a five-year classification of ships and oilrigs prohibits the next generation of services, where they argued alterations in the law to be necessary for developing and providing such services.

Normally, the oilrigs are to operate for five years and then follow the manuals provided by us on how and when maintenance is to take place. These manuals are inserted into their maintenance system which is calendar-based where the maintenance is performed thereafter. [...] When we began collecting data we were not that sure what to do with all this information, but the overall objective was to move from calendar-based maintenance to condition-based, thus seeking to avoid the five-year classification as much as possible. However, there are some regulatory requirements which states that "yes, you are to have this oilrig transported to the mainland for inspections and maintenance". This has nothing to do with the condition of the equipment, as if the rig has been operational 24/7 for five years there will of course be some degree of wear on the equipment. But if the rig has been a bit on and off and might have been operating on a well with some trouble where the utilisation has been low, it must still be classed after five years, no matter what. Therefore, we have to look at our services in conjunction with the regulations of the government, where these regulations should be altered to prohibit the future of services. – Chief Engineer, SPA

Though the government with their regulations acts as barriers for new services in these industries to be beneficial, the Norwegian government is perceived as willing to change and more forward leaning in this regard.

AS Norge is interested in having the operations in oil to become more efficient as this could generate more tax. Everyone will be best served by having these operations as efficient as possible and facilitate it. The government has not been the biggest issue, as they are rather forward leaning in this regard. – Chief Engineer, SPA

Some informants say that organizations that are focusing more on data and its potential benefits have trouble to recognise what the data should be used for, and how to handle it. When asked about ownership of data, every informant express this as a hot topic these days. As these companies are to share data with others, the issue of ownership could be difficult to define. In some industries, the government is developing platforms for handling and regulating this exact issue.

An exciting aspect of this is how the companies and providers in the electric power industry will in 2019 deploy a so called Elhub, where all information of power consumption will be collected from several grid owners and power providers. [...] When it comes to who owns this data, I am not quite sure. A lot of this data will be regulated by the government, where this Elhub is an attempt in regulating the power industry. But who actually owns the data might be a question of definition, as it could be the grid owners who own the equipment or if it is the private person who has a certain ownership of it. – Managing Consultant, ITCA

Not only are the Norwegian government focusing on how data is to be handled, the EU with their recent GDPR directive is also focusing on the issues of owning and handling data. This directive is meant to have every EU country, as well as the ones with the EEA agreement to manage and store data through the guidelines of the GDPR, where violation of these guidelines will bring fines of large sums.

Regarding ownership of data these days, the new GDPR directive is something almost every organization is quite concerned with. This is a legislation which permits pretty hefty fines if personal data for example is not stored in a correct way. You as a customer will now to a greater extent be able to request what data they have about you, and if you wish for some data to be deleted they must comply. [...] The GDPR will be launched 25th of May 2018. This legislation is rolled out by the EU and will also affect the EEA agreement which will function as a part of the new privacy policy. – Managing Consultant, ITCA



5 Discussion & Propositions

The research question I wish to answer is "what organizational changes occur when firms utilise digital technologies to move from being product-oriented to become more service-oriented, and which digital technologies could be used in this regard?".

Based on findings from the previous chapter, the research question will be attempted answered by discussing these findings in light of prior research presented in chapter 2. This discussion is structured in a way that the domains matches the ones presented in chapter 4. Propositions will be concluded in each domain to add new knowledge to the field of digital servitization. The notion of a comprehensive view will also be favourable for this chapter as well, and the first paragraph in each subchapter is also here a minor description of what follows to easier grasp its content. As mentioned in the previous chapter, distinguishing clear lines between the domains were difficult due to their content being relevant to other domains. This made it difficult to discuss each domain separately where cross-referencing to the chapters of 2 Literature Background and 4 Findings had to be utilised to illustrate the information's origin.

5.1 Products and Services

Both prior research and my findings indicate that more organizations are trying to move from being a provider of products to becoming a solution provider based on services (2.1.1, 4.1). Though traditional services such as spare parts, maintenance, and repair have been services that most manufacturing companies offer, there is an increasing tendency in providing more complex services by utilising digital technologies (4.1). Where a servitization strategy has originally focused on developing and providing services which will be supplementing a product (2.1.4), the digital aspect of digital servitization is focused on how this can be further improved and perfected (4.1, 4.3, 4.4, 4.5, 4.6).

Services are perceived as having higher profit margins and being a more stable source of income (2.1.2), where my findings indicate the same (4.1). This seems to be even more so when elements of ICT are utilised to strengthen the value and performance of the services as sensors and shared information could help organizations gain even greater insight into the businesses of customers and suppliers (4.1, 4.3, 4.4, 4.5, 4.6). This insight could enable the service provider and the supplier to easier adapt to each other, identify customer needs, and to develop service offerings which is more specifically aimed towards a given customer (4.1, 4.3, 4.4, 4.5, 4.6).



Lerch and Gotsch (2015b) concluded that a higher service orientation with more complex offerings led to a greater need for digital solutions (2.3.2), which seems to be a highly relevant conclusion (4.1, 4.6). As organizations and their products and services are increasing in complexity, the need for digital solutions to facilitate them is perceived as a necessity (4.1, 4.6). For these new and more complex services to become possible, more sources for gathering data both internally and externally will be required (4.5, 4.6). Internally revolves around having data collected from inside the organization, where external is regarding collecting data from other parties of the ecosystem as well as from the product and service in use (4.1, 4.3, 4.4).

The internal aspect of this could be data generated and shared from every department in the organization (4.3), where the external is meant to bring valuable information back to the firm which would be impossible to identify by only looking internally (4.4). It seems that this external aspect is meant to bring the service provider insightful information of their product or service in use within the operational environment of the user (4.1, 4.4). By gaining such insight, the organization could attempt to build competence and knowledge of this environment which could help them develop and provide more complex services (4.1, 4.3, 4.4, 4.5). With a strong digital infrastructure and methods for collecting data, this kind of information could automatically and instantaneously be transmitted back to the provider for further analysis (4.3, 4.4, 4.5, 4.6).

One of the major benefits of collecting and analysing data from the product in use is to address warranty issues with more precision where some of the same data could be used to more accurately assess the equipment's risk of failure (4.5). Oliva and Kallenberg (2003) saw this assessment as one of the challenges in providing services and indicated that a new set of skills in gathering data would be necessary to better predict failure rates (2.1.3). Data from internal and external sources by utilising ICTs and sensors could help organizations develop these required skills (4.1, 4.2, 4.3, 4.4, 4.5, 4.6).

As several organizations are focusing more on a single core business, competence-based services that seek to optimise and automate operations could increase in demand (4.1). For companies to provide such services, they will need to build competence around the operational field of their product where ICTs and sensors could help provide the information and capability to make this feasible. With this information, the provider of these services will be able to be more responsible for their product as they are the ones with the information on how the product is operating, and thus be more knowledgeable of the operating environment and the potential risks of failure (4.1, 4.5, 4.6).



Proposition 1 (P1): By gaining more information from several sources such as sensors and collaborators through elements of ICT, competence in the operational aspect could be acquired. This will improve the solution providers capabilities in offering more complex digital services and be more responsible for their product.

5.2 Culture and Human Resources

The research results suggest that a cultural change will be necessary for becoming a solution provider where such a change will be demanding and could take years to accomplish (2.2.3, 4.2). When seeking to provide complex digital services, new skills, competence, and resources will be required (4.1, 4.2, 4.3, 4.4, 4.5, 4.6). Where manufacturing companies previously consisted of engineers, they now consisting of a wider range of competence such as mechanics, electricians, and software developers (2.3.1, 4.2).

Not only will new kinds of personnel be required, the culture of the organization and their relationship with suppliers and customers must be altered to a higher service-orientation with their suppliers and customers in mind (2.1.4, 4.2, 4.4, 4.5). Oliva and Kallenberg (2003) stated that two distinctive transitions would be necessary for providing services where the first is to move away from transactional- to more relationship-based interactions (2.1.4). The second is to change the value proposition over to the customer and have the products become as efficient and effective as possible within the processes of the user (2.1.4).

For organizations to accomplish these transitions they are to focus more on their relationships in the ecosystem and build trust and loyalty with suppliers to secure that their offerings will be providable at all times, and at the same time increase the capabilities of continuous improvement (2.1.4, 4.2, 4.5). One recommended alteration in this regard is to break down the barriers of silo mentality both between the departments within the same organization as well as the external relations with customers and suppliers (4.2, 4.3, 4.4, 4.5). By establishing channels of communication with ICTs, a flow of communicated information could be achieved (4.3, 4.4, 4.5, 4.6). This will require every party in the ecosystem to have a common understanding that this information would be valuable for all participants, and therefore be both a receiver and sharer of data (4.2, 4.4).

The second transition of value proposition revolves around how the product is operating in use (2.1.4), where information of the operating environment could facilitate capabilities in how to optimise operations (4.1, 4.2, 4.4, 4.5, 4.6). With a channel for communicating back experiences and data uncovered by service technicians and analysis of data from external sensors, the



solution provider would be better enabled to identify how their product could be improved, and how the operations and processes of the customer could be optimised (4.2, 4.3, 4.4, 4.5, 4.6).

The findings highlight a new way of thinking do drive service offerings further, and a larger part of the organization will have to associate themselves with the customer for new and more complex digital services to be recognised and realised (4.2, 4.3, 4.4). For companies to accomplish this, fresh and openminded people who have not yet been influenced by an obstructive culture could be used as ambassadors for the coming change towards services, and have them practise the new ways of working, could reduce the tension associated with the change (4.2). In a seminar arranged by EY Alumni (07.06.2018), speakers highlighted how more organizations see the importance of hiring younger people with knowledge of IT and the ability to think new and stresses the value of these people being adaptable to allow for a culture of change rather than just changing the culture. However, this will not be possible if management do not wish to facilitate change (4.2).

Proposition 2 (P2): Fresh minds and new ways of thinking could act as an enabler for recognising and realising complex digital services as newly hired and openminded personnel could help to drive a cultural change and facilitate a culture of change. Shared acknowledgement of the value of leveraging data must be at the centre of this culture.

5.3 Structure

When companies utilise digital technologies to pursue a servitization strategy, it seems that they are focusing on the potential benefits of the digital within services (4.3, 4.5, 4.6). Some organizations are having one or several departments explore these benefits and look at how they could be utilised in their present and future offerings (4.3). Some also make acquisitions of ITbased companies to attain more knowledge and competence in this regard. Due to the digital aspect of the products and services are becoming a central element, it is perceived as important to have knowledge and competence of this domain within the organization itself instead of outsourcing (4.1, 4.3).

In a blogpost about how traditional companies can compete with born-digital companies, Maurice (2018) argues that traditional companies could keep up with the digitalisation race through three suggested tips. Firstly, get inspired by digital companies as it could be beneficial to explore what digital companies do and how they conduct their business, and learn from best practices. Secondly, partner up with digital companies to fill in the missing gap of competence and knowledge. And thirdly, take advantage of technology to leverage data. Even though this



is a whitepaper publication, my findings indicate that her three tips are highly relevant (4.1, 4.2, 4.3, 4.5).

As the notion of continuous improvement is seen as important for organizations to develop and offer complex services, both my findings and prior research indicate that having communication and sharing of knowledge to be a central part of the culture would be advantageous (2.1.3, 4.2, 4.3, 4.4, 4.5, 4.7). Cenamor et al. (2017) argued the value of bridging the front-end and back-end offices to enable knowledge from both offices become visible for the other (2.1.3). It seems that it will be necessary for structuring the organization to allow such communication channels to be better enabled in identifying the wishes and needs of the customers, thus improving capabilities in providing services through transparency (4.2, 4.3, 4.4, 4.5, 4.6, 4.7).

For organizations to identify and understand the customer, larger parts of the organization will have to associate themselves with the user (2.1.4, 4.3). This does not necessarily imply that more people in the organization are to have contact with customers, but by having the front-end offices who are in direct contact, communicate their knowledge with the rest of the organization, could be helpful (4.3). Such transparency could also help break down barriers associated with silo mentality where such a mentality is perceived as highly destructive for the successfulness of providing customer-centric offerings (4.2, 4.3).

Another aspect which seems relevant in structuring departments of the organization to facilitate new and complex digital services, is the need for personnel in the different departments to be knowledgeable of the others (2.2.3, 4.3). This is more specifically meant to manage the IT:Business relationship where employees in IT might not understand the business perspective and vice versa. Both Hoberg et al. (2015) and Westerman et al. (2012) stated that knowledge of this relationship is key to success in digitalisation context (2.2.3). To have managers in the business and IT departments be knowledgeable, or at least understanding, of what goes on in the other, the organization would be more capable of grasping the opportunities of potential future offerings and prevent misunderstandings in what is perceived as doable or not (4.3). This can also be achieved by having cross-functional teams collaborate when developing new products and services (4.3).

Proposition 3 (P3): For organizations to become more service-oriented which involve becoming more customer-centric, the wishes and needs of customers could be recognised easier by structuring the organization with channels of communication between all departments. This could also contribute to breaking down barriers of silo mentality.



5.4 Network

It is evident how companies that seek to provide services are in need of building good relationships with customer and suppliers for insight, stability, and continuous improvement (2.1.2, 2.1.4, 4.4). By emphasising openness in the whole ecosystem which the service provider is part of, the provider could be more capable of gaining expertise from external sources (4.4). By establishing a collaborative platform in the ecosystem for sharing and receiving information, this could be accomplished in countless industries (4.4, 4.5, 4.6, 4.8).

As more companies are attempting to servitize by utilising digital technologies, products and services are to a greater extend embedded with IT and ICT, complexity increases (2.3.1, 4.4, 4.5, 4.6). According to Yoo et al. (2010), services and products are being embedded with digital capability due to the digital's extraordinary improved price:performance ratios which will inevitably alter their design, production, distribution, and use (2.2.2). By looking at the evolvement of digital technologies for the last decades, this will keep evolving and continue to do so with exponential growth if we are to take Moore's law² into consideration.

When products and services become more complex with embedded digital technologies, the complexity, abstraction, and problem-solving skills needed by employees will increase significantly (Lerch & Gotsch, 2015a)(2.2.3). Organizations must therefore seek to attain these skills, if not already present within the walls of the company, through acquisitions or collaborations in the value-chain (4.2, 4.3, 4.4). As the larger and more resourceful organization tend to acquire ownership of their chain through vertical interactions (Neely, 2007)(2.1.3), the smaller and less resourceful organizations seek to open up for sharing information with partners (4.2, 4.4, 4.5).

Before organizations could begin to share data, good relationships and trust with other companies in the value-chain will be necessary to prevent dependencies and cases of opportunism (2.1.4, 4.4). This can be accomplished by entering partnerships with the intent of "if we do well, so will you and vice versa" and try to adapt to the partner and further complement each other (4.4). As soon as good relationship based on trust has been established, transparency can be accomplished. Some organizations even build such relationships by showing their cards and initiate a partnership with sharing of data as a basis for building trust (4.4).

² Moore's law state that integrated circuits will over time exponentially improve in terms of reliability, cost, performance, and power consumption (Moore, 1998).



When products and services are becoming more complex with the embedding of digital elements, there seems to be numerous ways for the digital to be exploited (2.2.2, 4.4, 4.5, 4.6). Both prior research and some of my informants state that with the uprising of smart objects, the opportunities of how they could be used are limited only by imagination (2.2.2, 2.3.1, 4.1, 4.4, 4.5). A good network of partners and players from different fields would be advantageous to recognise these opportunities (4.3, 4.4). The vast implications for smart objects would be difficult to notice without looking at the opportunities from more than one perspective. It is argued that emphasising the whole ecosystem could be applicable in understanding your role and the roles of others in this system, therefore be better capable of recognising where your digital services could be of value and further realised in this area (4.4). In this regard, where data is at the centre when emphasising ecosystems, it could be appropriate for organizations who are to digitally servitize to look at this ecosystem from a digital perspective; thereof "digital ecosystem".

With a growth in complexity facilitated by digital technologies, new players have entered the field who seek to establish platforms for capturing and analysing data (4.4). As mentioned, larger organisations seek vertical integration through acquisitions where smaller ones seek the same through openness and collaboration. Companies could establish a collaborative platform where partners and other players could insert and extract data (4.4). With emphasis on the ecosystem, organizations could identify which players that could be of value to include in such a collaborative platform (4.4). These platforms may consist of all kinds of valuable information, where measurements from sensors, results from analysis, experiences, competence, and knowledge are examples of what could be inserted (4.4). The notion of partnerships and insight into each other businesses are important due to the understanding of data in these platforms are necessary for recognising and realising its value (4.2, 4.4). A good example of a platform-tool which is meant to collect, analyse, and visualise any kinds of data to deliver insight through the organization is Microsoft's newly released interactive data visualisation BI tool – *Power BI* (Power BI, 2018).

Proposition 4 (P4): By establishing collaborative digital platforms, service providers and their collaborators are more capable of complementing each other and adapt to better provide more complex digital services in different areas. With emphasis on digital ecosystems and utilising data in platforms, these areas could be easier identified.



5.5 Processes, Capabilities, and Data

In the era of Lean Thinking, manufacturers as well as others are focusing on finding new ways of working and delivering value to customers while eliminating waste perceived as non-value adding. Processes and capabilities are to be continuously improved where data in real-time is now a central part of this new way of thinking (4.5). Customers are seeking more instant and customised responses, where providers will have to optimise their processes to improve their capabilities (2.2.2, 4.5). The delivery of new and more complex digital services could not be feasible without data being transmitted in real-time and managed with precision (4.5). Digitalising processes for the sake of automating, could help service providers manage the issues regarding the complexity of these higher advanced offerings (2.2.2, 2.3.1, 4.5, 4.6).

Organizations who are to provide digital services at a speed that customers are satisfied with will have to automate and optimise repetitive, boring, and manual non-value adding operations (2.2.2, 4.5). It will be important to see big picture in understanding operations and processes being automated to identify the causes and effects of the optimisation (4.5). As more operations are automated, employees previously working in these areas may have time released as a result, and could focus their energy elsewhere (Parviainen et al., 2017)(2.2.2, 4.5). By digitising and digitalising boring and manual work, job satisfaction may increase as employees are challenged with in tasks, an may have more time for competence building through courses, certifications, and continuous improvement initiatives (2.2.2, 4.5).

As organizations are seeking a digital servitization strategy, they tend to focus on implementing more sensors and other sources for gathering data from both internal and external areas (2.3.1, 4.5). According to Parviainen et al. (2017), this could facilitate a better real-time view of operations which will provide organizations with information to gain better accuracy in processes (2.2.2). By gaining a better understanding of the internal operations, continuous improvement initiatives would be easier to implement as the required information would be accessible (2.2.2, 4.5). From the external perspective, capabilities in grasping the operational environment could be improved which again will allow for better recognition of customer's needs (2.2.2, 4.3, 4.4, 4.5).

All the data collected from different sources should be combined in a single system to enable efficiency by automating manual work and reduce rework (4.5). A high functioning ERP system connected to the same system as sources of data in warehouses, orders, invoices, sales, operations, and documents will be valuable as these operations could be automated and thus



increase efficiency tremendously (4.5). EHFs is a tool which could enable these operations to become connected in such a system (4.5, 4.6). When providing digital services, this type of efficiency based on data in real-time will be essential. Oliva and Kallenberg (2003) argued the pricing mechanism of servitized companies to be a challenge as services are more difficult to price due to the uncertainties involved (2.1.3). Though this is not something I intended to study, my findings indicate that with more data and information from several sources, service providers could address this issue with greater capability and precision (4.5). As more processes are being automated, where efficiency in delivery increase as a result, the service paradox (2.1.3) could be managed (4.5). Data from external sources could also help service providers to improve their first-time fix rates when dispatching service technicians as information about what is to be repaired and the required tools to fix it is available (2.3.1, 4.5, 4.6). This will reduce the chances of unfortunate and unforeseen scenarios, and reduce the costs associated with such situations (4.5).

When manufacturing companies are becoming servitized, they often struggle to shake the perception of being a provider of equipment (2.1.3, 4.2, 4.5). The promoters and sales personnel could have difficulties in becoming more service-oriented as they traditionally sell products (4.5). With a higher service-orientation, these people are to emphasise more on services and communicate the service's value to the buyer instead of focusing on the product itself. This will require education and training in selling differently where knowledge of the services is to be at the centre (4.5). Correspondingly for the promotion of digital services, knowledge and competence in digital technologies will be advantageous as well.

Proposition 5 (P5): For organizations to be able to offer complex digital services, processes and capabilities must be digitally automated and improved in efficiency. As the market is increasingly demanding more instant responses, processes and capabilities must be based on real-time data and preferably connected to the same system for data and responses to be handled as instantaneous and accurate as possible.

5.6 Digital Technologies

Companies in the process of becoming digitally servitized are as mentioned focusing on digitalising internal operations to increase efficiency thus facilitating digital services. It seems that they are also utilising digital technologies in the pursuit of exploring potential services for the future where the vast collection of data could be analysed to reveal them (2.2.2, 2.3.1, 4.6).



With more sources for generating data in every possible area, it is granted that the sizes of these databases will be enormous. Traditional tools for managing and analysing data will not be sufficient (2.2.1). To be able to handle the massive amounts of data generated, competence in big data will be of importance (4.6). The proposed platforms where IT-companies are providers of such, servitized manufacturers could work with these companies to enable a collaboration of shared competence (4.4, 4.5, 4.6). The manufacturers are the ones with knowledge of their product and the environment in which it operates, where providers of platforms will be more competent in digital technologies and how to manage data (4.4, 4.5, 4.6).

Collecting and handling vast amounts of data often raise concerns about security and its reliability. Security revolves around unauthorised access and manipulation, and reliability is about the data being fully transmitted with accurate content. Blockchain technology could be applied to validate and secure entries and preserve historic records (4.6). It is perceived as quite difficult, if not impossible, to gain access and manipulate or extract data stored in blockchains (Crosby, Nachiappan, Pattanayak, Verma, & Kalyanaraman, 2016).

To further improve the efficiency of internal processes, machine learning (also known as AI) could be written into the system which contains the collected data. For example, by combining historic data, methods of EHFs, and data from different departments with the ERP system, an AI trained to understand the different variables could update the ERP automatically with accuracy and speeds far greater than the capabilities of humans (4.5, 4.6). Such AI codes could be implemented in countless beneficial ways where only the definition of your problem limits its potential (4.6). An example from aquaculture, AI and sensors are used to monitor the fishes temperature and movements to quickly identify sickness and quickly isolate the healthy from the unhealthy. Again, the possibilities of AI and sensors are limited only by imagination.

For service providers who offer complete and complex systems, a digital twin of the system could be beneficial in increasing the providers capabilities in monitoring and control (see 4.6 for findings on digital twins). A digital twin is a virtual representation of the entire system where real-time data from sensors and historic data are combined to enable preventive maintenance. The same data could be used to simulate operations for optimisation purposes where virtual analysis is performed to test the potential improvement. By exploring the applications of digital twins, service providers could reveal new services in the process. For example, if something cracks or breaks, the error will be highlighted in the digital twin with information about what happened before and during the breakdown. The system could be remotely shut down to dispatch a service technician, or even be remotely repaired. As the digital



twin can be seen as a virtual map of the system, technician could use AR glasses where information provided by the twin could guide the technician to the correct location and display through the glasses what needs to be corrected. At EY Alumni's seminar, representatives from Equinor talked about how VR glasses with information from a digital twin are used to enter the wells and pipes to observe the conditions and orient themselves within the digital twin. Another mentioned how new hospitals will use VR glasses for training purposes. Similar technologies are used in construction where a virtual representation is designed in building information modelling (BIM) to utilise VR to gain better understanding of what is to be built.

With digital systems being connected to more sensors and technologies such as digital twins, a strong digital infrastructure with a capable bandwidth will be required for the data to reach its destination and free of errors. As systems could be operating at distant locations, the digital infrastructure might not suffice. Here, methods of edge computing could be utilised for performing local analysis of the data and only transmit the results or the required information (4.6).

Proposition 6 (P6): Digital technologies such as remote monitoring, predictive analysis, blockchain, digital twin, edge computing, IoT, EHF, AI, AR, and VR could improve the service providers capabilities in offering complex digital services, and by analysing data generated and used in such technologies, new services could be recognised and realised.

5.7 Operating Environment and Market

One of the domains which revealed itself to be interesting were in the subjects of operating environment and market. Though these subjects are not as relevant to my research question as the previous six domains, this domain was perceived as interesting if we are to take providence of digital servitization into consideration. As there are countless competitors in every industry, there are often large players who dominate a majority of the market. These companies are perceived as more capable of becoming servitized due to their resources and ability to make acquisitions in the value-chain and seek vertical integration in this manner (2.1.3, 4.4). When acquiring the whole chain, offering complete systems with complementary services could be more feasible and the value from every sale and service are retained by the same organization, but it could also make the organization less flexible and more bureaucratic (4.4, 4.5). Due to technological advancements and the utilisation of data, the market seems to be altering where even small and medium-sized enterprises (SMEs) could accomplish similar capabilities (2.2.2, 2.3.1, 4.4, 4.5). The market is changing where customers are more aware of their needs where



flexibility, customisation, freedom of choice, and instant response are some of their longings (2.2.2, 2.3.1, 4.1, 4.5, 4.7). According to my findings, it suggests that the larger and more bureaucratic organizations are not as capable of delivering to such demands, where SMEs could be perceived as more capable (4.1, 4.4, 4.5, 4.6, 4.7).

In conservative industries, the larger players seem to be dictating how the operating environments are to function prohibiting the market and environment to evolve (4.7). New and more complex services are focusing on the operational aspect of their equipment and seek to optimise the processes in which it operates (2.3.1, 4.1, 4.5, 4.6, 4.7). The business models of larger organizations and communication between involved parties acts as barriers for such services to be offered by SMEs. However, in the conservative market of oil, alterations of the industry are on the horizon as oil companies, operators, suppliers, and service providers are beginning to realise that communication is key for improvements (4.7). The resent crisis in this industry could be the source for the eye-opening, and some believe, or at least hope, that the industry will evolve drastically over the next decade (4.7).

The world is continuously evolving within electronics and computers after it was initiated by the industrial revolutions of the past (2.2.2, 4.1, 4.7), where more equipment and machinery are increasingly based on electric motors and computer capabilities (4.1). The potential opportunities within computer sciences are perceived as limitless where electric motors and computer-based machinery could bring these opportunities to life (4.1, 4.5, 4.6). After Caterpillar launched their electric motors almost twenty years ago, equipment in the oil industry came to be more electrified where data-based services are becoming a possibility (4.1, 4.7). More organizations are beginning to look forward where Statoil's recent renaming to Equinor could be seen as a good example of this. They are trying to shake off the perception of oil with more focus on renewable energy instead of being limited to oil and gas, hence the name – Equinor; equi from equal, equality, and equilibrium, and nor from the pride of their Norwegian origin ("Statoil skifter navn til Equinor," 2018). At EY Alumni's seminar, the VP of Equinor's IT platform talked about their ongoing digitalisation projects where the goal is to enable condition-based maintenance. The newer and more complex oilrigs have approximately 100,000 sensors installed, whereas the old ones would have less than a hundred. He argued that by utilising the value of data through sensors and insert them in platforms – operational costs could be reduced by 20%.

Another aspect that could bring changes to the industrial economy is advancements in wireless technologies. The rise of IoT could bring a completely new perspective to manufacturing where



sensors with highly capable and reliable wireless connections could be an element that drives this revolution (4.7). The forward-looking founder of Tesla and SpaceX – Elon Musk has begun his plan to establish a worldwide wireless network with internet connectivity; the so-called Starlink. In the beginning of 2018, SpaceX launched their Falcon 9 rocket to deliver the first prototypes of 12,000 orbital satellites which will deliver wireless network to every single location on Earth (Kettley, 2018). Additionally, the common wireless standard of 802.11ac is soon to be replaced by Intel's new 802.11ax which is meant to drive the revolution of smart objects (Vena, 2018). This standard will supposedly be launched at the same time as the new 5G mobile broadband (Bie, 2018). Both 802.11ax and 5G are meant to focus on smart objects by delivering more reliable and 24/7 wireless connections, reduce latency by dynamically monitoring the traffic of data, reduced power consumption, improved capacity with more objects connected to the same network, and improved down- and uploading speeds (Bie, 2018; Vena, 2018).

The conservative industries of oil and maritime have not experienced much disruptive change (4.7). However, some believe that the recent advancements in IoT where technological innovation manifested in smart objects and integrated product-services will radically reshape industries and the world as we know it (Frishammar et al., 2015)(2.3.1, 4.7). This will, according to several researchers bring the third industrial revolution to new heights (Brettel, Friederichsen, Keller, & Rosenberg, 2014; Huxtable & Schaefer, 2016; Jazdi, 2014; Lasi et al., 2014; Lee, Bagheri, & Kao, 2015; Lee, Kao, & Yang, 2014; Porter & Heppelmann, 2014, 2015; Rüßmann et al., 2015; Weyer, Schmitt, Ohmer, & Gorecky, 2015). Due to the tremendous boost in productivity and the economic growth this could potentially bring, the movement has been coined Industry 4.0 or the fourth industrial revolution to differentiate it from the third. Industries in all sectors are allegedly to be affected by this revolution, which will bring disruptive changes to everyone involved (2.3.1, 4.7).

Proposition 7 (P7): With the upcoming evolution of wireless connectivity, technological advancements manifested in wireless smart objects and integrated product-services could bring disruptive change in numerous industries, where alterations of business models and ways of doing business could drive the offering of complex digital product-services to become feasible for any organization.



5.8 Laws and Authorities

The other domain that was revealed as interesting is how laws and authorities could act as both a barrier and driver for the offering of complex digital services (4.8). Similar to the previous subchapter, this domain does not supplement my research question either. However, regulations in industries could prohibit solution providers to offer more complex services as there are minor value in realising these offerings, where alterations of these regulations could act as a driver for facilitating such services (4.7, 4.8). Issues surrounding ownership of data could also bring difficulties for providers of digital services where laws and initiatives such as GDPR and the Norwegian Elhub could help to tackle these issues (4.8).

Regulations of the oil and maritime industries impose that oilrigs and ships are to be inspected and serviced every fifth year through a five-year classification. This prohibits providers of condition-based and preventive maintenance to draw value from such offerings (4.7, 4.8). Regulations and legislations in this manner acts as barriers for more complex services to be valuable where alterations will be a necessity for these services to flourish (4.7, 4.8). Fortunately, the Norwegian government is perceived as forward-looking and willing to change their legislations to allow condition-based maintenance which will at the same time allow for services focusing on optimisation of operations to prosper (4.8).

When it comes to the issues of handling and owning data, the GDPR directive was approved by the EU Parliament in April 2016 and launched in May 2018 to harmonise data privacy laws across Europe. It is however postponed for implementation in Norway until the beginning of July. This directive is meant to protect and empower EU citizen's data privacy and reshape the way organizations approach data privacy (European Commission, 2018). This could be seen as a direct consequence of what Cambridge Analytica was able to accomplish with the recent election of America's new president in early 2016 – Donald Trump. Cambridge Analytica was able to collect digital information of 87 million Facebook profiles, and supposedly used this information in targeted political advertisement in favour of Trump's presidential campaign (Kanter, 2018). This incident is perceived as one of the main reasons for the actions of the EU Parliament to roll out the GDPR directive, which contains legislations of guidelines on how data are to be stored and managed. Violations of these guidelines could bring fines as high as €20 million, or 4% of the worldwide annual revenue of the prior financial year; whichever is higher ("Fines and Penalties," 2018). In countries which are members of the EU, every organization who obtain data will have to focus more on how the data should be managed and stored as a result of this directive being launched.



The Norwegian government is not exactly known for allowing businesses to do as they please, as they often try to regulate different industries through legislations and state-owned companies. Though there are many industries in which they are involved, the more well-known are in the fields of banking (DNB), oil (Equinor), rail transport (Flytoget and NSB), healthcare (Helse Midt-Norge, Helse Nord, Helse Sør-Øst and Helse Vest), lottery (Norsk Tipping), post office (Posten Norge), internet and mobile broadband (Telenor), liquor (Vinmonopolet), and providers of electric power and the grid (Statkraft and Statnett). Statnett have recently established a subsidiary called Elhub which is responsible for implementing key business processes in the market of power. This consists of communicating data about power consumption, ensuring that customers can switch providers, and that correct information about the customer is available to participants in the market who have legal access to this information at all times ("Elhubs Personvernerklæring," n.d.). This hub of information about the electric power market could be perceived as a collaborative platform which was discussed earlier in this chapter and could bring new opportunities in this industry where power providers and grid owners could collaborate to advance and perfect the market of power (4.4, 4.5, 4.8). And since the Norwegian government are involved in several industries, similar initiatives could be implemented elsewhere to drive different service providers to new heights.

Proposition 8 (P8): Authorities with their legislations seem to work as a barrier for more complex digital services to be deployed where alterations in the law and establishing collaborative data platforms could facilitate the offering of complex digital services to prosper.

5.9 Summarising the Theoretical Contributions

The intended research areas presented in the original framework for the research (Figure 2-5) were supplemented with new domains as new and interesting perspectives presented themselves while analysing the empirical findings. This thesis' theoretical contributions will be summarised below for clarification due to the difficulties in distinguishing clear lines between the domains above, and a new framework will be presented to visualise the contributions.

Prior research on servitization stresses the importance of insight into other's business to allow for more complex services to be recognised, where the value proposition of their offering is meant to be on the customers side. Within digital servitization, with emphasis on information being generated and communicated, companies could gain greater insight and will be better equipped to develop complex digital services e.g. specialised services for optimisation.

P1: By gaining more information from several sources such as sensors and collaborators through elements of ICT, competence in the operational aspect could be acquired. This will improve the solution providers capabilities in offering more complex digital services and be more responsible for their product.

A servitization strategy is known to require a cultural change towards service-orientation with a customer-centric mindset; new skills, competence, and resources will be essential to accomplish this. My findings indicate that acknowledgement of digital technologies and leveraging data will be an elemental part of a digital servitization culture. This acknowledgement should not be limited to the organization itself but shared throughout the network of partners in the ecosystem. Younger and openminded people are perceived as more adaptable to the coming changes in technologies, and it would be beneficial to include such people as they could aid implementing a culture of change rather than just changing the culture.

P2: Fresh minds and new ways of thinking could act as an enabler for recognising and realising complex digital services as newly hired and openminded personnel could help to drive a cultural change and facilitate a culture of change. Shared acknowledgement of the value of leveraging data must be at the centre of this culture.

Within the field of servitization, the notion of service-orientation implies a higher focus on customers, where the field of digitalisation stresses the importance of knowledge of the IT:Business relationship. Larger parts of the organization would have to associate themselves with customers, therefore a wider knowledge base will be required. By considering the fields connection in digital servitization, structuring the organization with channels of communication to share knowledge will be advantageous. The notion of IT:Business relationship, should according to my findings be expanded to IT and every other department. This include the departments of service, product, development, HR, sales, business development, procurement, finance, administration, etc. For IT to understand how and where knowledge should be shared, every department should be taken into consideration. An organizational structure in this manner could grant transparency and thus break down barriers of silo mentality.

P3: For organizations to become more service-oriented which involve becoming more customer-centric, the wishes and needs of customers could be recognised easier by structuring the organization with channels of communication between all departments. This could also contribute to breaking down barriers of silo mentality.



Previous research indicates that organizations who are to servitize should emphasise the ecosystem and develop a network of partners to widen their competence and improve capabilities. By emphasising the ecosystem, the network of partners is meant to enable collaboration to further complement each other and adapt to one another. With more focus on data, and how data could be utilised, my findings suggest a digital platform could be established in a digital ecosystem to allow for this with greater capabilities.

P4: By establishing collaborative digital platforms, service providers and their collaborators are more capable of complementing each other and adapt to better provide more complex digital services in different areas. With emphasis on digital ecosystems and utilising data in platforms, these areas could be easier identified.

With higher focus on customers and the growing demand for instant response, companies must optimise processes and capabilities. Organizations who are to implement a digital servitization strategy would have to obtain a holistic view of their processes to know where and how initiatives of digitalisation could be applied. Data in real-time is essential for the delivery of complex digital services, where all data should preferably be connected to the same system to allow for instant and reliable data transmissions.

P5: For organizations to be able to offer complex digital services, processes and capabilities must be digitally automated and improved in efficiency. As the market is increasingly demanding more instant responses, processes and capabilities must be based on real-time data and preferably connected to the same system for data and responses to be handled as instantaneous and accurate as possible.

Prior research suggests digital technologies such as remote monitoring, predictive analysis, IoT, AR, cloud computing, and big data can be relevant for organizations who are to digitally servitize. Though it is mentioned that these technologies could improve the servitization process, little attention has been set to understand how this could be accomplished. In my findings; blockchain, digital twin, edge computing, EHF, and VR are other technologies that would be beneficial to consider. With enormous amounts of available data, new market segments could be identified by analysing the data.

P6: Digital technologies such as remote monitoring, predictive analysis, blockchain, digital twin, edge computing, IoT, EHF, AI, AR, and VR could improve the service providers capabilities in offering complex digital services, and by analysing data generated and used in such technologies, new services could be recognised and realised.



Both my findings and prior research points to that industries and markets are soon to experience alterations; where the widespread appliance and advancements of digital technologies could be the source of these disruptive changes that are yet to come. My findings show that conservative industries and authorities prohibit alterations to occur, where service providers and other organizations are in need of looking forward to facilitate change. Frishammar et al. (2015) stated that technological innovation manifested in smart objects and integrated product-services will radically reshape companies, value-chains, industries and ultimately the whole world. Where my findings suggest further development of wireless technologies could revolutionise some industries, Frishammar et al. (2015) statement was expanded to take wireless connectivity into consideration.

P7: With the upcoming evolution of wireless connectivity, technological advancements manifested in wireless smart objects and integrated product-services could bring disruptive change in numerous industries, where alterations of business models and ways of doing business could drive the offering of complex digital product-services to become feasible for any organization.

The organizations are not the only ones in need of looking forward. Governments must do the same by altering regulations and laws for the purpose of facilitating change. Providers of complex digital services are prohibited to draw value from possible offerings due to regulations. Especially in Norway where there exists a strong digital infrastructure, the Norwegian government could potentially initiate disruptive changes in countless industries.

P8: Authorities with their legislations seem to work as a barrier for more complex digital services to be deployed where alterations in the law and establishing collaborative data platforms could facilitate the offering of complex digital services to prosper.

To finalise my contribution, I would revaluate the definition of digital servitization which is described as "the provision of digital services embedded in physical products" (Vendrell-Herrero et al., 2017, p. 69). There is more to it than embedding digital services in physical products; as the whole organizations, their way of thinking, and the way of developing and delivering services are to change for a digital servitization strategy to become successful. A combination of the definitions of digital transformation and servitization may provide a more comprehensive definition: "Digital servitization is the profound transformation of organizational activities, processes, capabilities, competencies, and models to fully leverage data and the opportunities in digital technologies and their accelerating impact across society



in a strategic and prioritized way, to better create mutual value through a shift from selling products to selling Product-Service Systems embedded with digital technologies, with present and future shifts in mind". To illustrate how this research contributes to the field of digital servitization, the original framework has been updated to visualise this contribution. As mentioned, operational environment, market, laws, and authorities were not meant to be researched. However, these domains were perceived as too interesting to ignore and will be further discussed in 5.11. In Figure 5-1, the contributions are visualised with propositions attached to their relevant domains.

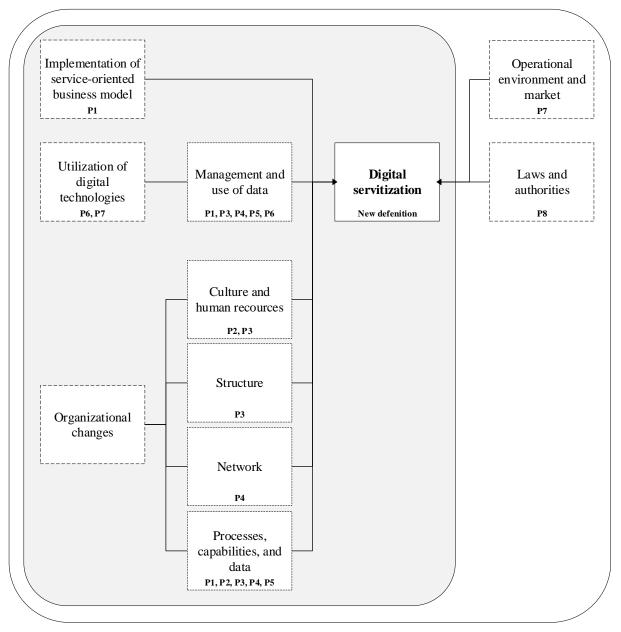


Figure 5-1, Updated framework for the research included with appropriate propositions



5.10Practical Implications

For organizations who are to implement a digital servitization strategy, there are some practical implications of this research which is worth mentioning. When initiating digitalisation projects to automate processes, a holistic view would be beneficial to identify causes and effects of the initiatives. There should not be a focus on removing the need for employees as these could sit on valuable information and tacit knowledge which could be applicable to be used elsewhere; and even used as a basis for training AI's. An acknowledgement of data's value should be a central part of the culture, where the culture should be shared beyond the boundaries of the organization. Every department and every worker should be aware of the benefits of sharing data, where digital infrastructure and the structure of the organization in general should be organised to allow for instant and accurate flow of data. Digital platforms, with emphasis on a digital ecosystem, could be established to accomplish this with enhanced capabilities. And by gaining competence in BA and BI, data in such platforms could be analysed to identify new ways of delivering offerings as well as new offerings in present and future market segments.

With the recent launch of GDPR, organizations and governments are to handle and store data with great care to avoid undesirable fines. Everyone involved with generating and storing data are to increase their focus on security, where my findings suggests blockchain technologies to be an alternative to secure and validate data. Organizations and governments will have to look forward and alternate in parallel with the advancements in technologies, this to facilitate disruptive changes which could drive the economy to new heights.

5.11 Limitations and Further Research

The quality of data and findings in research are often referred to the three areas of *validity*, reliability, and generalisability. The first is about the validity and relevance of the collected data for the research question which is to be answered (Larsen, 2012, p. 80). The second revolves around the precision and reliability of the research process (Larsen, 2012, p. 80). The third is about how findings could be generalised and proven relevant for other industries or areas (Tjora, 2012, p. 207). Though these are perceived as highly relevant in assuring the quality of quantitative research, some argue their relevance to be of less importance for qualitative research (Bryman, 2016, p. 383), though some aspects of these could be applicable for my study. I will attempt to prove the quality of my research by discussing some accumulated experiences and thoughts about limitations of the study where further research will be suggested.



Tjora (2012, p. 203) state that a thorough investigation of a subject would increase the following research's reliability. However, by investigating too thoroughly the researcher could attain a bias view and become bigoted in revealing new and relevant perspectives. As I have performed an intensive review of available research where more than the initial scope of the study was explored, such bias view might have affected my research due to the difficulties in sticking to the intended scope. He also states that reliability would improve if there are more than one researcher involved in the study. Due to this research being conducted singlehandedly, it was perceived as a weakness as thoughts and perspectives could not be discussed with a peer. However, with the help of my supervisor who is knowledgeable in the field of servitization, peer-discussions were accomplished through workshops and emails.

Regarding generalisability, Tjora (2012, p. 207) imply that quantitative research are more capable of generalising their findings as the whole population of their research could be analysed. He states that generalisation is to be viewed differently in qualitative research as data are gathered from a smaller population than in quantitative researches. It would be unfortunate to try and generalise my findings of organizational changes in a servitization process, as this could be different for other companies than manufacturers. However, the digital aspect of this research could be generalised to some extent as every sector and industry are utilising digital technologies in one way or another. The world is continuously becoming more digitised where digital technologies and the rise of IoT are supposedly to affect countless industries. A suggestion to further research could be to explore how elements of IoT could be beneficial in a certain industry. Additionally, when IoT are implemented in different industries, investigating the benefits and opportunities of IoS could bring valuable information for several businesses.

The intended variation in sampled cases were not accomplished as originally hoped for, where an effort was made to supplement this with IT consultants. By investigating a broader range of case companies with more variation in cases, the subject of digital servitization could potentially be explored to a greater extent. One weakness was that audience with one of the consultants was a result of snowballing where this method rarely directs the researcher to cases not related to the one who directed you. Another weakness of my research was that only one person or a couple were interviewed in the case companies. This reduces the chances of gaining several perspectives as I experienced the interview with SC to be valuable due to there being four participants. Therefore, more informants within a company could bring more depth to the research. SC have not gotten far in their process of becoming servitized, which was early on



perceived as undesirable. While analysing the data, this proved to be false as it revealed some issues that the other cases already had overcome and therefore did not perceive it as relevant.

Based on prior research and the empirical contribution of this thesis, further research could be conducted to assess the validity and reliability of the propositions and try to define how organizations should proceed with implementing such changes. Due to the "how" being excluded from the research question to limit the scope of this study, the question of "how are organizations utilising digital technologies to facilitate the offering of more complex digital services?" could be applicable to explore in depth.

The discussion and propositions in 5.7 and 5.8 are not that relevant to my research question, but their content was too interesting to ignore. The propositions from these two could form a basis for further research on how operational environment, market, laws, and authorities should be altered to drive the offering of more complex digital services. The seventh proposition is an expansion of a statement identified in prior research but with more focus on wireless connectivity. Here, it would be interesting to investigate how advancements within wireless technologies could be beneficial for present and future offering of complex digital services. Regarding laws and authorities in a Norwegian context, it would be interesting to research what laws and regulations should be altered, and what they should consist of to allow for more complex digital services. It would also be compelling to explore which industries the Norwegian government could implement similar initiatives as Elhub, how it could be done, and how this could potentially drive the Norwegian economy further.

Due to this study being in a Norwegian context, similar research in other countries could be beneficial to identify other practices and methods used within digital servitization. Industry 4.0 have been defined and explored by the German government (Lasi et al., 2014) where Germany is recognised as a world leader in industrial automation (Rüßmann et al., 2015). Cases from Germany regarding Industry 4.0 could therefore be of value to further contribute to the field of digital servitization.



6 Conclusion

The purpose of this study was to explore how organizations change in the process of digital servitization and what digital technologies could be utilised in this regard. Due to products and services being embedded with more digital elements, the complexity of product-service systems is increasing and will require organizations to alter. With increasing competition in industrial markets and the growing demand for customisation, flexibility, freedom of choice, and instant response, digital technologies could be utilised to better recognise customer's needs and be better equipped to meet them.

Where a servitization strategy is focusing on developing and providing services which will supplement a product, the digital aspect of digital servitization is more focused on how this can be further improved through data. With the increasing complexity of products and services, organizations must acquire new skills in gathering data and competence in how to manage and make use of the data. By establishing both internal and external sensors and other elements of ICT for the purpose of gathering and communicating data, valuable information could be obtained, and capabilities improved. This may help break down barriers of silo mentality where such mentality is perceived as destructive when attempting to become more service-oriented and customer-centric.

For organizations to obtain the required skills and competence, there is a tendency in emphasising the whole ecosystem and make acquisitions or enter into partnerships with companies that could be applicable to pursue. The case companies are interested in acquiring or entering partnerships with players in a digital ecosystem and gain closer interactions with customers where data seem to be the basis for collaboration, insight, and continuous improvement. By gaining insight into the processes of customers and obtain knowledge and competence from collaborators or acquired companies, the solution providers are focusing on the operational aspects of their products and how customer's operations could be improved; where data and insight could bring valuable information for revealing and further develop more complex digital services. This could be accomplished by acknowledging the value of data, where a culture of perceiving its importance throughout the ecosystem will help organizations achieve transparency and thus become more capable of recognising and realising such services.

A method within Business Analytics and Business Intelligence is to establish a digital platform on top of the organization where data from sensors, results from analysis, experiences, competence, and knowledge would be inserted. Collaborators and customers could also be



included in the platform to generate even more information. The vast amounts of data within such platforms, and the competence required to develop them will require skills in handling and analysing data. Knowledge of big data will be necessary where organizations often acquire or collaborate with IT-companies for the sake of tackling this issue. Large sizes of data are often a subject to concerns about security and the accuracy of data where blockchain technologies could help to secure an validate its content. It is perceived as important to employ younger and more openminded people who are more knowledgeable of IT than previous generations. The opportunities of smart objects (IoT) within digital services are limited only by imagination where new ways of thinking are essential for complex digital services to be identified.

With the increasing role of IT in all aspects, the relationship between IT and business must be addressed. It will be important to structure the organization with personnel in each department who are knowledgeable or at least understanding of the other departments; and establish good channels of communication to achieve transparency. It will be necessary for every department and each level of the hierarchy to acknowledge the importance of transparency through sharing of data. As complex digital services are based on data in real-time, continuous improvement of processes and capabilities is important to enable more instant responses. Repetitive, boring, and non-value adding operations should be automated through digitalisation to allow for data in real-time to be processed as instantaneously as possible. By establishing a strong digital infrastructure and connect every digital aspect of the organization to a single system or platform, the ERP supplemented with EHFs and AI could improve efficiency in operations and thus enhance the capabilities of offering more complex digital services. AI could be beneficial in numerous ways and areas, where the definition of your problem sets limits to its potential appliance. As organizations are taking advantage of digital technologies and data to facilitate complex digital services, the data could be analysed to reveal new offerings. Complex products could be built virtually as a digital twin where this twin may be used as a tool for monitoring and control which will allow for condition-based and preventive maintenance. By analysing data and the appliance of a product's digital twin, new services and capabilities within AR and VR are at the dawn of widespread adoption where new and unknown appliances are yet to be identified.

Though the three industrial revolutions of the past have been named after they took place, the coming revolution within IoT has already been suggested to become the fourth. As Industry 4.0 is at its early stages, following its evolvement and what it will bring for the future should be interesting for most people. I for one, am thrilled to start my career in the 4.0 era.



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Appendix

A.1 – Declaration of Consent

Samtykkeerklæring for deltagelse i forskningsprosjekt

«Masteroppgave om Digital Servitization»

Jeg, Gøran Sæland, skriver våren 2018 en masteroppgave på studiet Industriell økonomi og Teknologiledelse (Indøk) ved institutt for ingeniørvitenskap på Universitetet i Agder avd. Grimstad. Oppgaven har som tema «*organisatoriske endringer i prosessen av digital tjenestefisering (servitization)*» med et høyere fokus på de eksterne elementene i tillegg til bruk av digitale verktøy som hjelpemiddel og/eller driver for endringsprosessen. Som del av prosjektet skal jeg undersøke hvordan og hva bedrifter gjør i denne prosessen, og hva som kan tyde på å være «riktigere» valg for et mer vellykket utfall.

Deltagelse i studien vil innebære intervju med varighet på omtrent én time. Spørsmålene vil omhandle selskapets endringsprosess, samt informantens roller og erfaringer knyttet til dette. Intervjuet vil bli tatt opp med lydopptak som transkriberes i etterkant, og det vil bli tatt notater underveis. Vil også påpeke at lydopptaket vil bli slettet så snart det er blitt transkribert.

Jeg er underlagt taushetsplikt, og alle personopplysninger vil bli behandlet konfidensielt. Det vil kun være meg og min veileder som har tilgang til innsamlet data. All data vil anonymiseres, hvor navn og koblingsnøkkel vil være adskilt fra øvrige data for å sikre konfidensialitet.

Både bedriften og enkeltpersoner vil anonymiseres i publikasjon, slik at deltakeren ikke vil kunne gjenkjennes. Prosjektet skal etter planen avsluttes Juni 2018 og all data vil da bli slettet. En kopi av oppgaven kan sendes ut til informanter om ønskelig etter endelig levering. Det er frivillig å delta på denne studien, og du kan trekke ditt samtykke når som helst uten å oppgi noen grunn.

> Student Gøran Sæland gorans12@student.uia.no 984 68 633

Veileder Tor Helge Aas tor.h.aas@uia.no 990 92 927 / 38 14 20 04

Jeg samtykker herved å delta i intervju

(Deltakerens signatur, lokasjon og dato)



A.2 – Interview Guide

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Big Data, Sky, IoT, Digital infrastruktur?		endringene forekom?		Hensikt, parallelt?
				Retrospekt?
Digitalisering? Forstyrrende endringer? 		Big Data, Sky, IoT, Digital infrastruktur?		
		Digitalisering?		Forstyrrende endringer?



NettverkHvordan er nettverket endret?UVerdikjede?	
\Box Elementer – Ecosyst	emet?
□ Leverandører – Partr	here?
□ Transaksjoner –	
Relasjoner?	
Hvordan har relasjonen til kunder endret seg?DNye aktører?	
□ IT aktører?	
Levering (eksterne prosesser)?	orers
rolle?	
Samhandling med kunde, og behandling av 🛛 Co-creation?	
informasjon?	
Struktur Hvordan er organisasjonsstrukturen endret?	
□ Risiko?	
Sentralisering, desentralisering?	
□ Vertikal integrering?	2
Decision making?	
Strukturelle endringer ellers i markedet?	
KulturHvordan er kulturen endret?DNy avdeling?	
□ Ny kompetanse?	
□ Ferdigheter?	
Mer kundeorientert?	
Outputs – Outcomes	?
Innstilling, orientering, tankesett?	
Digitalisering?	