

SERVITIZATION IN THE MANUFACTURING INDUSTRY

G.L. Sebregts

Master's Thesis Environment and Society Studies Program
Specialization: Corporate Sustainability
Radboud University
Nijmegen School of Management
August 2021

Colophon

Title: Servitization in the manufacturing industry

Submission date: August 30th, 2021

Author: Gijs Sebregts

University: Radboud University

First reader & supervisor: dr. Duncan Liefferink

Second reader: dr. Mark Wiering

Host organization: Brabantse Ontwikkelings Maatschappij, Goirlese Weg 15, 5026 PB Tilburg

Supervisor at internship: Marieke Huis in 't Veld

Referencing style: APA

Preface

Dear reader,

In front of you is my Master's thesis that forms the finishing touch of my time as a student and the start of a new chapter. This was my second thesis during COVID 19 times, and although it seems like things are getting better it is still difficult getting used to work at home in such circumstances.

My time at Radboud University started in 2017 with the Bachelor's program Geography, Spatial planning and Environment. A program I chose because of my preference for geography, but during this phase I got more and more engaged with the environmental aspect. I realized that there is an enormous challenge wherein I want to contribute during my professional career. I experienced the highlight of my student days during the autumn of 2019, when I spent a semester at University College Dublin. A place where I grew a lot as a professional in this field, but also as a person. Therefore going abroad is something I could recommend to every student.

After coming back to the Netherlands I finalized my Bachelor program and in September 2020 I started the Master's program Environment and Society Studies with Corporate Sustainability as a specialization. Also at Radboud University in Nijmegen, although most of the times I worked from home in Oirschot. Despite that, I still got more engaged with the sustainability topic where I see a lot of opportunities in the private sector.

I was lucky enough to write this thesis for a great organization that provided me good support during my thesis. My weekly meetings with Marieke and my longer meetings with Marieke and Paul helped me to shape my thesis in the right direction. With their experience and network in this field, they could provide me the tools I needed to write this thesis. Despite the few hours I could work at the office I still experienced the Brabantse Ontwikkelings Maatschappij as a very warm and welcoming organization. I also want to thank my supervisor Duncan Liefferink. From distance, he supported me as well with some very productive Skype sessions and our frequent e-mail contact.

I am excited to see what the future brings and I hope you enjoy reading this thesis!

Gijs Sebregts

August 2021

Abstract

This thesis is about the circular economy, and especially about the business model servitization in the manufacturing industry. Servitization shifts the focus from offering products to offering services and this different use of products could lead to circularity as manufacturers have more grip on their products and thus they can keep these products in the cycle. With these new business models manufacturers can also more easily adapt to the customers demand and they can intensify their customer relationship. This is an approach that made a lot of progress during the last few years and multiple entrepreneurs start implementing this new way of running a business and it is interesting to discuss the opportunities and barriers (Martinez et al., 2009). This new model is connected to another problem that occurs in the manufacturing industry according to the Brabantse Ontwikkelings Maatschappij. This is the relationship between Original Equipment Manufacturers (OEM) and suppliers. These are two parties which are depending on each other, but which are also willing to become circular. This could lead to an OEM that wants its supplier to become circular while the supplier is not able to, but it could also be a supplier that wants to become circular, but which cannot because it cannot live up to the demands of the OEM. In this research the implementation of a servitization business model for such organizations is discussed.

To answer the proposed questions the following research question has been proposed:

- What are the main opportunities and barriers for business in the manufacturing industry towards a servitization business model?

The answer research question is answered through two main frameworks. First is an assessment of the kind of services businesses do already offer through the framework of Tucker (2004). This framework shows that servitization is not a binary concept, but a continuum with different hybrid forms between fully product-based towards fully service-based. This shows the difference in embeddedness of service in their organizations. Furthermore the framework of Martinez et al. (2009) is used to find the main opportunities and barriers through five main challenges being:

- Embedded product-service culture
- Delivery of integrated offering
- Internal processes and capabilities
- Strategic alignment
- Supplier relationship

This research is a multiple case study. Four cases in the manufacturing industry have been researched and from each of these cases the aim was to also speak with a supplier to enable to speak about the supplier relationship from both perspectives. There is extra emphasis on the supplier relationship as this was the main problem that the BOM identified prior to this research. Besides the stakeholder there were also interviews with experts who could provide some insights about the topic in general.

The most important opportunities that were found were the long term customer relationship that servitization provides. With an embedded service the relationship will be extended after the customer receives the product and end-of-life the Original Equipment Manufacturer could also take back the product and provide a new one on a service basis. These constructions enable to build a long term relationship with mutual satisfaction. Servitization also forces to think about efficient spare part management. Extra servicing could also lead to a longer operationality of products, lower costs and lower depreciation and this can lead to higher margins. Products will be provided on a service basis and this forms an incentive for Original Equipment Manufacturers to obtain efficient sustainable use of materials to reduce the costs. An extra advantage is that this also leads to more circularity and it this could be enforced by new innovations and technologies that facilitate more

efficient management. Besides this also the increasing governmental legislation forms a threat for business who are not working circular and servitization provides a great opportunity to go in that direction and avoid governmental regulations.

The main barriers that have been identified are the change of culture that is needed in organizations with an embedded way of working through the years. Also the kind of service that will be provided should be clear. What kind of service would be beneficial and what kind of service would not? Servitization also implies reusing, refurbishing and remanufacturing of products and businesses with no experience need to find a way to facilitate that, which is both financially as logistically a challenge. Also the mutual expectations between OEM and customer on the output needs to be sorted out when people want to start working on a service level.

If businesses are suitable for servitization does depend on the type of product. Commodity products do fit the servitization idea more as they enable to standardize and scale-up while more customized products require a more specific approach end the output is difficult to define. Regarding the supplier relationship it seems that the smaller more replaceable businesses are more vulnerable to powerful Original Equipment Manufacturers than the bigger suppliers with a more distinctive product.

Keywords: Circularity, manufacturing industry, Servitization, Supplier, Original Equipment manufacturer

Table of content

| | |
|---|----|
| Colophon | 2 |
| Abstract | 4 |
| Table of content | 6 |
| 1. Introduction..... | 8 |
| Research aim and questions..... | 11 |
| Scientific relevance..... | 12 |
| Societal relevance..... | 13 |
| 2. Literature review | 14 |
| What is servitization? | 14 |
| Remanufacturing | 15 |
| Circularity | 16 |
| Opportunities and barriers on servitization | 18 |
| Supply Chain | 20 |
| Theoretical framework..... | 21 |
| Operationalization..... | 24 |
| 3. Methodology | 26 |
| Research design..... | 26 |
| Philosophy of research | 26 |
| Validity and reliability of the research | 27 |
| Data analysis..... | 28 |
| 4. Results | 31 |
| Type of product service systems | 31 |
| Embedded product-service culture..... | 32 |
| Delivery of integrated offering..... | 33 |
| Internal processes and capabilities | 36 |
| Strategic alignment | 38 |
| Supplier relationships..... | 40 |
| 5. Conclusion | 44 |
| Embedded product service culture | 44 |
| Delivery of integrated offering..... | 44 |
| Internal processes and capabilities | 45 |
| Strategic alignment | 46 |
| Supplier relationship | 46 |

| | |
|--|----|
| Discussion | 47 |
| Recommendation for the BOM | 49 |
| Recommendations and future research..... | 50 |
| Reflection and limitations | 50 |
| 6. References..... | 52 |

1. Introduction

Circularity is a very current topic which will shape the future of the global economy. A circular economy is focusing on the optimal deployment and reuse of raw materials in different parts of the production chain: from the extraction of raw materials until consumption. The idea is that these materials will constantly be reused which will lead to less extraction of raw materials from nature and less waste. Raw materials will become scarce in the future and a growing global population with growing wealth does enlarge this scarcity while the needs are growing. Therefore efficient use of raw materials will become more important. This provides new chances for companies: new markets that respond on these developments, more cooperation between parties regarding the material use, less raw material use and new business models that fit the idea of circularity, instead of the current more linear business models with input of raw materials and output that predominantly results into waste (PBL, 2016). Less waste and efficient material use will lead to lower costs as there is no need to buy new raw materials because of the circularity. Important is that end-of-life products will not go to waste, but will go back into the chain to make a new product of it and keep the whole chain circular.

According to the European Commission the transition towards a circular economy is an opportunity to transform the economy to generate a new and sustainable economic competitiveness for Europe. To make these ambitions in practice several governmental organizations set clear goals related to the circular economy. The European Green Deal is a European program related to environmental and climate issues and each European Union member has to comply with this agreement. Circularity enables to keep more grip on products and to use them more circular which results in avoidance of scarcity and lower costs. It obliges to think about (technological) innovations and by doing this in an early stage with smart solutions we can grow a competitive advantage with regard to the circular economy (European commission, 2019). This does also demand new business models that support this circular economy.

The Dutch government complies with this European agreement and they want to shape this in the Netherlands by the following three principles:

1. People should make more efficient use of materials during production processes so less materials are needed.
2. When raw materials are needed, people should make use of sustainable produced renewable materials that are widely available like biomass. This makes the Netherlands less depending on fossil sources and it improves the environment. In addition, it also has geopolitical advantages as it makes the Netherlands less depending on parties abroad.
3. There should be developing of new production methods and circular design of new products.

The long term goal is to be 100 percent circular in 2050 with 50 percent less raw material use in 2030 as an intermediate step (Dutch Government, 2019).

This circular economy is also relevant on a local level, for example in the province of North Brabant in the Netherlands. National and international businesses have to be mobilized for this circular economy, and the estimation is that this will take 25 years – a whole generation – to transform businesses and its value chains. This means that the next five years are crucial to make plans to become circular in 2050 (European commission, 2019).

This transition provides the opportunity to involve sustainable jobs and new business models in economic activities. There is an enormous potential on global markets for technologies with low emissions, sustainable products and services. Therefore also the circular economy has a great potential for new activities and jobs worldwide. This transformation is still progressing slowly and

there is a huge demand for a widespread uniform approach. The European Green Deal can accelerate this transition of the European industry towards a sustainable model of inclusive growth (European commission, 2019). The transition towards a circular economy can provide a great contribution to reduce the environmental footprint and the resource use of our economy, and by doing this it improves the long term security of the economy as well (TNO, 2019).

The province of North Brabant has presented some goals and priorities for the provincial policy for the next few years. This is called the Bouwstenennotitie Circulaire Economie (Building Blocks Note Circular Economy) 2019-2028. In this program there is emphasis on the manufacturing industry which has a deeply rooted in the economy and society of Brabant with companies such as ASML, Philips, but also Mutsaerts Textile in Tilburg. (TNO, 2019). The role of the manufacturing industry is increasingly relevant, not just because of its impact on raw material use and the environment, but also because of ICT developments and innovations in the manufacturing industry that could form a great addition to the circular economy. More efficient material use, innovation and economic opportunities are main triggers for companies to change and circularity is an additional advantage for them. This is also something which involved parties are interested in to see how they can implement such practices in their day to day businesses (TNO, 2019). Especially for the manufacturing industry this is a great challenge. These three Dutch principles on the circular economy do also account for the manufacturing industry, as they make much use of raw materials that can do harm to the environment, for example metals. The third Dutch principle is particularly applicable for the manufacturing industry. Through legislation and regulations regarding circularity, the governmental forces to think about their product designs how to make them suitable for the circular economy and how their material use can be improved efficiently. This could be done by redesigning products which enables remanufacturing or refurbishment in an easier way.

Circularity is a broad concept and even in science there is not absolute agreement how to define this concept. It is a concept that has evolved the last decade and several governmental organizations, such as EU, promote this as the new way to shape the economy in the future and also businesses are adapting to it (EU, 2019). Despite the total body of science around it, the concept is still superficial and unorganized (Korhonen et al., 2018). There are several ways to implement circularity and approaching circularity as a whole is too broad. Therefore, to narrow it down, this research will mainly focus on the implementation of a service model called servitization. This is a concept that can be used in line with circularity. Servitization is the transformation process in which production companies start focusing more on services and the development of service to meet the customers' needs, improve the organizations' performance and gain a competitive advantage (Innovatie Zuid, 2013). This enables manufacturers to keep more grip on their products over the years and they can intensify their customer relationships. By offering products as a service, businesses have more control over their products. Customers make use of it, but the product is still owned by the manufacturer and end-of-life they do also take back the product. By doing this they have more grip on materials and they can pursue a more efficient material use and this also has more circularity as a result. Servitization basically forms a shift from owning oriented to using oriented, as it will be based on the use of the product instead of owning the product. When businesses keep track on the materials and start to deploy them end-of-life for new products it will lead to more circularity.

Servitization makes, as mentioned, a switch from product-based thinking towards customer-based thinking. The differences between those two approaches have been outlined by Innovatie Zuid in the table below (2013). One of the main differences to highlight is the focus. Where product-based is almost primarily focused on the product itself, is service-based focusing on the needs of the consumer. Product-based offers a product while service based has an integrated service that aims for making use of the product with the longest possible lifetime and comfort instead of owning it. Another important characteristic of a service based transaction is the extended relationship that a

company establishes with its customer. Instead of selling the product without any agreement there can be a long term service contract where the selling party guarantees the customer the use of the product. This gives them extra responsibility but is also enables them to make more profit on the long term.

| | SERVICE BASED | PRODUCT BASED |
|-------------------------------|-------------------------|------------------------|
| FOCUS | Customer | Product |
| 'PRODUCT' | Process experience | Physical |
| VALUE CREATION | At customer | In own company |
| FACTORS OF SUCCESS | Relation and brand | Technology |
| CHARACTER OF SELLING | Relational | Transactional |
| CHARACTER OF BUSINESS | Returning (Stable) | Incidental or cyclical |
| REVENUE MARGIN | Relatively high | Relatively low |
| BASIS PRICE SETTING | Value for customer | Costs of the product |
| CULTURE CARRIER | Service | Engineering |
| PRIMARY ROLE OF ASSETS | Utilization | Ownership |
| OFFERING TYPE | Service integration | Physical product |
| PRODUCTION STRATEGY | Mass/pure customization | Mass production |

Table 1: Service-based vs Product-based (Source: Innovatie Zuid, 2013))

The table suggests that this is a binary concept, but subsequently in this research will be shown that there are many forms in between where both concepts can be combined. In recent years companies already started exploring if they could add some kind of services to their product delivery.

Vandermerwe and Rada (1988) already described the process of businesses adding services to the product they sold to increase their revenue, competitiveness and their position in the market. They started to combine the concepts service and goods instead of keeping these two things separated. Later this even got enforced by things such as support, knowledge and self-service.

A lot of businesses are willing to comply to the climate goals that have been set recently as it is essential for their long-term earning capacity through legislation and regulations by the government. There seems to be political consensus that the circularity will shape the future European economy and thus they have to adapt to this situation (European commission, 2019). This is where the Brabantse Ontwikkelings Maatschappij (Brabant Development Agency), or shorter: BOM, gets involved. The BOM is a growth accelerator who supports local entrepreneurs, bigger companies and other pioneers to solve societal challenges and realize ambitions in the Brabant economy. The two main shareholders of the BOM are the Ministry of Economic Affairs and Climate and the Province of North Brabant. This enables them to determine the course of the BOM and they also help the BOM financing their projects. This means that the BOM also has to justify their expenses and actions to these parties and they partly finance the projects that the BOM has with the intention to accelerate the sustainable circular economy in Brabant, according to the government's ambitions.

The main competences of the BOM are developing, investing and internationalization. By doing this they can help companies in the region of Brabant to grow, just as the Brabant economy itself and its competitiveness. Brabant has a great competitive position with a lot of innovative and technological manufacturing companies and for the BOM the aim is so sustain and improve this strong position as they recognize the potential of Brabant on a global level (BOM, N.D.).

The BOM does a lot of work in the manufacturing industry. This industry is one of the main areas in which servitization is about to be implemented as there is a lot of potential to improve in this sector by becoming circular through servitization. Research of TNO (2019) shows that a significant amount of businesses are willing and sometimes even able to become more circular. The question for them is

how to accomplish this in an affordable and efficient way. This is a challenge that is occurring at businesses in the manufacturing industry. Sometimes they are too much depending on their partners that makes it difficult to go in that direction. In this case there are two general situations from which point of view there will be made a description:

- An Original Equipment Manufacturer (OEM) that wants its suppliers to become more circular.
- A supplier that wants to become circular, but which is bounded by the demands of the Original Equipment Manufacturer.

An OEM has a lot of power over its suppliers and the OEM has noticed that some of these suppliers feel themselves disabled by this OEM to move towards circular business models, such as servitization. Another situation was a supplier that wanted to become more circular, but that it could not combine this with its duties towards their customers, mostly OEM's.

Suppliers, but also Original Equipment Manufacturer are willing to become more sustainable, but because of their interconnectedness and their dependence on each other, several companies are struggling with this situation. Sometimes businesses do not have the resources or do they not have the priorities in that direction.

Other common problems towards implementation of servitization is that just few companies have the possibilities, the strategy and the leadership to implement such propositions successfully (PA consultancy Group, 2017). Some respondents in this PA Consultancy Group research state that they get too little top-down support for the development of new business models, such as servitization. They say that a lot of leaders prefer a risk avoiding approach (PA consultancy Group, 2017).

Research aim and questions

The aim is to map the main opportunities and barriers, for suppliers and OEM's to implement a servitization business model. The literature shows that servitization offers several advantages, either from the environmental perspective as well as the economic perspective. It is interesting to determine which factors influence decision-making process of implementing a service based business model. Besides that is also important to explain which advantages servitization offers to businesses in the manufacturing industry. To address these issues the following research question will be answered:

Main question

- What are the main opportunities and barriers for business in the manufacturing industry towards a servitization business model?

To answer these questions the framework made by Martinez et al. (2009) will be used. They provided five main challenges during the implementation of a servitization business model and this framework will be applied and tested in this research to help answering the main question of this research. These five main challenges are:

- Embedded product-service culture
- Delivery of integrated offering
- Internal processes and capabilities
- Strategic alignment
- Supplier relationships

Due to the earlier mentioned issues that appear between OEM's and suppliers there will be extra emphasis on the fifth challenge. This will be tested from OEM's perspective, but also from supplier's

perspective to provide and both sided view on this relationship. In the end also an assessment will be made about the kind of service that is being offered. Tukker (2004) identified eight general types of Product Service Systems (PSS) and it is interesting for each of the cases to examine them by this framework and see how far they are servitized and what kind of service they actually offer or are about to offer. In the end also a recommendation for the BOM will be made to discuss what role they could play in this process and if they can improve certain processes with regard to this topic.

For this research four cases have been selected from the BOM network. Each of them being a business in the manufacturing industry, but each of them also with another product to have a diverse set of respondents with each their own opportunities and barriers. The BOM organized an interview with each of them in favor of this research and these interviews have been processed in the results section. Bellow follows a brief description of each of the four cases.

- Hapert: This is a business from Hapert who delivers high quality trailers. They are market leader in the Benelux with their product.
- ASML: This is a big chip machine maker that is located in Veldhoven. With a turnover from about 14 billion euro's they are a global player who sells its products all over the world.
- Vencomatic: Vencomatic produces poultry farming equipment and is located in Eersel. Vencomatic does sell their products all over the world and does also try to help poultry farmers to work more efficient and sustainable. One of their supplier that has been interviewed is wholesaler Van Egmond.
- Chainable: Chainable is a young start-up in the kitchen industry and is located in Gilze. Their ambition is to produce a circular kitchen and their business model is already servitization-based. Supplier ATAG, which provides kitchen equipment, is also involved in this research.

Scientific relevance

The concept of circular economy has made a significant growth during the recent years. It has been promoted and encouraged by EU and national governments and also lots of businesses are more engaged with the concept. Despite this being the scientific body of knowledge on this topic it is still quite superficial and unorganized (Korhonen et al., 2017). Therefore this research aims to go more in-depth and focus on a specific business model that could help shaping the circular economy, being servitization. Focusing on servitization can help to extend the existing practical knowledge on this specific area and it provides tools that could also support the circular economy. Baines et al. (2009) already tried to define servitization by making a review on the existing literature with a reflection on the future challenges related to this topic. They described the difficulties that organizations face, for example not having the practical knowledge how to make the transition successful. Benedittini et al. (2015) described in their paper why most why a lot of servitized companies fail, being the great internal risks that appear for the supplying business. Other papers such as the Whitepaper servitization (Van der Putten, 2018), that consulted Praetimus and the PA Consultancy Group, project way more positive figures related to servitization. This paper can form an addition to this by implementing the images they drew in a practical context and by addressing the opportunities and barriers they described. There is a research gap on this topic and this paper can help to address and hopefully help to fill this gap. This paper also forms an application on the already existing literature of Tucker (2004) and Martinez et al. (2009). These are dated, but still relevant theories on servitization and this research brings these theories into practice. In the literature review several elements of servitization are discussed and through the framework that the papers of Martinez et al. and Tucker provide the opportunities and barriers regarding servitization will be identified and assessed. Servitization is a concept that brings lots of opportunities, but also barriers. For product-oriented manufacturing companies the transition towards service-oriented is complicated. The internet provides global, but also local roadmaps that should support businesses by outlining the existing

problems and knowledge gaps, but this research dives more into the businesses-specific problems and can therefore form an addition to that.

Societal relevance

Circularity is a topic that has become increasingly relevant in the last decade. It has become more and more part of the mainstream policies and ambitions and thus do companies also have to deal with this. The issue is that this is an unknown area for a lot of businesses and therefore more research and knowledge is required to support these businesses. For the BOM there is an interesting challenge with regard to this. Their goal is to mobilize this required knowledge in the province North Brabant and help the local companies to solve societal challenges and realize ambitions. They can guide businesses in the right direction and by doing this they can have a significant impact by helping businesses to improve which is also beneficial regarding sustainability and circularity. By researching what the main challenges are towards circularity and servitization this research is relevant for manufacturing industries. With the increasing implementation of circular business models new research on this can help to extend the existing knowledge about this topic, especially with regard to servitization. By accelerating the implementation of servitization business models, this will most certainly increase the circularity which will benefit the earning capacity on the long-term for businesses. Business partners of the BOM, and also the earlier described literature stated that many parties are willing to cooperate and join the circular economy, but that they simply do not know how and where to start. This paper creates a practical example of the implementation of servitization in the manufacturing industry. It identifies opportunities and barriers during the transformation to servitization and therefore can be used as a tool or guide for future activities. It could help other similar businesses, and maybe even businesses from other sectors, with the implementation of this new business model. In this case the involved businesses will not be directly connected with the consumer, as it will be partly aimed on suppliers and it is interesting to see how they can adapt to concepts as servitization. In the end it is also important to keep in mind the different types of businesses that will be analyzed. Depending on the businesses that will be analyzed it is also interesting to see to which extent findings can be generalized to make the outcome of this research also applicable on other businesses or sectors.

2. Literature review

In this research the possible opportunities and barriers during the application of servitization in a manufacturing supply chain will be tested. To create a proper starting point a critical review of literature is required. This chapter outlines the different forms of servitization, the benefits and burdens of servitization environmentally-wise and economically-wise, describes the concept supply chain management, the concepts remanufacturing, refurbishing and reuse and talks about the possibilities of servitization related to circularity.

What is servitization?

Servitization is progressing. More and more enterprises are offering subscription-based products where advice and maintenance is included. A growing number of production companies is only offering services like finance and advice, but others are changing their business model as a whole and offer their products as a service only. Lamp manufacturers, such as Philips, are not offering lamps but light. Car producers do not offer cars, but driving hours. Instead of owning a product, consumers will switch to using a product according to an underlying service agreement. An example is Swapfiets, where people make use of their bikes against a monthly payment. Swapfiets also provides the service and guarantees the consumer a functioning bike. Switching from the provision of production to the provision of services can bring huge advantages. It can lead to an increase of turnover and margins (PA consultancy Group, 2017). Customer relationships will be enforced which is essential for the success of this business model. For companies that do not sell products but services, their customer relationship is from huge importance. An important reason why customers could embrace servitization is the high level unburdening that servitization could provide, related to the equipment, but also by avoiding unexpected (high) costs through service contracts. The longer the customer stays satisfied, the more revenue the company generates. The focus is moving from transaction to relation and the results could be a stable sustainable source of income (PA consultancy Group, 2017).

Adding services to products reduces waste and it increases the reparability which extends the lifetime (White et al., 1999). Another advantage of the intensified customer relationship is that they have the right to let their products be repaired by the manufacturer and it is likely that people will make use of this. That leads to less demand for new products which is positive for the environment. In an ideal situation manufacturers involve their suppliers and consumers in their process of green supply chain management and this interconnectedness supports the proposal of environmental goals as Mishra and Shah (2009) described. This could be targets like lower material use, less emissions or the use of safer materials. By doing this the manufacturer could also give the good example and teach their partners about environmental behavior (Hao, et al., 2021). In this way partners can replicate this behavior and behave more sustainable as well and reduce costs. With all these measures combined it is more than likely that environmental performance objectives might be realized. Lower use of resources, less energy use during this process and discharge of waste will lead to better results and thus a positive impact of servitization on the environmental performance (Hao et al., 2021).

Generally speaking servitization will lead to more repairing, less waste and a longer lifetime of products and if more organizations embrace this model it could significantly support the circular economy. The question is how organizations should implement servitization . Servitization business models can appear in different forms and each company may apply in their own preferred way. There is no such thing as an one-size-fits-all model regarding servitization. The Boston Consultancy Group (2009) made an general overview of these different types and gradations of servitization and they presented this in the attached table 2.



Table 2: Overview of servitization businesses (Source: Boston Consultancy Group, September 2009)

Lots of manufacturing companies deliver beginning-of-life-services like installation, testing and preparation of equipment. Some companies also offer lifetime services, such as repair and revision, but also consulting. Each of these traditional lifecycle services, as mentioned in table 2, are product-related and are being delivered by the traditional business model of the related company. This is also applicable to the enhanced technical services that are mentioned in table 1 (Innovatie Zuid, 2009) in the introduction. Table 2 shows the more traditional forms of services such as maintenance and repairing, but it does also already pay attention to technical innovations, despite the datedness of the table. Anno 2021 services like monitoring with the use of big data have only been intensified and this is an important service that companies do offer nowadays. It needs to be mentioned that not each of the services in table 2 is directly related to a product, but it still provides a general overview about the type of services that can be offered.

Relevant concepts that are not included in this table are the possibilities of remanufacturing, refurbishing and reuse. In table 2 it could be added to the end-of-life services with the difference that this is more circular. Remanufacturing implies the rebuilding of a product in the original way with the spare parts from the old product. Refurbishing is when an end-of-life machine gets repaired and becomes good as new and reuse is when a machine gets used at some other places when it normally would go to waste. As mentioned these are an end-of-life services, but they also form a link with circularity as it meant to work more efficient with raw materials and spare parts. These are concepts that are relevant for the manufacturing industry as they are also seeking for more efficient material use. In the next chapter there will be an extra emphasis on the concept manufacturing, but the ideas are also applicable on reuse and refurbishment.

Remanufacturing

Remanufacturing is a concept that can help to overcome the challenges related to servitization and the circular economy. In 2013 the Roadmap Remanufacturing got published in the province of North Brabant (Innovatie zuid, 2013). This forms a guide for entrepreneurs in the manufacturing industry to capture the potential of remanufacturing as good as possible, which was not yet the case at that time. The idea is that old and maybe even outdated machines will be retrieved by OEM's from their customers. When they have this old machine back they start to repair for reuse, refurbish and

remanufacture to give the machine an 'as good as new' status. By doing this the lifetime of the machine can be extended and it can provide the OEM new service revenues. It also provides the customer who buys the machines a more affordable alternative than a new machine and it makes the OEM less sensitive for conjunctures (Innovatie Zuid, 2013).

The reason for the Roadmap Remanufacturing was the lack of utilization of the opportunities that remanufacturing offers for local manufacturing companies. There is a lot of potential being the ability to meet the customers' demands in a better way, having a better selling proposition and gaining extra income by the provision of service and remanufacturing (Innovatie Zuid, 2013). Companies face barriers regarding the design of the organization where it is difficult to manage both the new and the used machines within the same organization. This is very costly and complex to organize, especially for smaller companies with less financial possibilities. Next to a production unit, businesses should also establish a remanufacturing unit and especially for the smaller businesses this can be complicated regarding the financials and the logistics as they do not have the same sources as the bigger organizations. Some businesses even decide to build an external department that is mainly based on remanufacturing to make a clear division between the regular production and remanufacturing. A good example is De Meeuw from Oirschot (De Meeuw, 2021). They make units that can be used for flexible housing. They have their regular production line, but also a production line where they remanufacture older units that came back after it was being used for a temporarily housing project. By doing this they can easily divide these two practices, but not every business can afford to establish this for itself. Besides that there is also a lot of competition from 'brokers' who offer used machines for a low price. They cannot guarantee the same quality, but they still can gain their market share by their low prices and this forms also competition for the OEM. The roadmap is meant to provide a guide for manufacturing businesses and it outlines some relevant opportunities and barriers that businesses can face regarding the implementation of remanufacturing in their organization.

With this roadmap they try to improve the international competitive position of Dutch high-tech industries and it is also meant to support new innovations and it forms an incentive for e.g. service-businesses as it creates a lot of opportunities for such organizations to engage in this (Innovatie Zuid, 2013). Practices such as reverse logistics, remanufacturing and refurbishment often need to be organized besides the daily production and this makes it a very complex operation. Despite that it provides businesses a lot of opportunities for new cooperation, markets and production processes. For businesses it is vital that these opportunities will be explored to see what specific opportunities will be applicable to their organization. This can be individually, but with the presence of so many big, but also small businesses there is also a lot of potential to explore these new markets together and see if they could help each other in the right direction (Innovatie Zuid, 2013).

Circularity

These are the economic benefits, but there are also sustainable reasons to become servitized and to start reusing, refurbishing or remanufacturing products. First of all because of the changing legislations around climate and energy related to Corporate Social Responsibility (CSR). CSR means taking responsibility for the impact of your business operation on man, the environment and society. With CSR, you address or prevent poor working conditions, environmental pollution and poverty. In this context the environmental impact is relevant for businesses in the manufacturing industry as they tend to have a significant environmental impact during their production. CSR does depend on the sector, size, culture and the business strategy of a company. For manufacturing companies specific related to this topic CSR urges businesses to focus on things like CO2 emissions, saving energy and efficient use of raw materials. CSR is not mandatory, but it could provide advantages to a business, apart from the positive impact of CSR itself (Dutch Enterprise Agency, 2021). To guide the businesses towards CSR they introduced the guidelines of the Organization of Economic Cooperation and Development (OECD). These guidelines form the Dutch government's expectations about how

companies should act relative to CSR. It is a broad set of recommendations that should help companies to work in the desired way and strives to endure social progress and a lot of these principles do also apply on the manufacturing industry, and circularity is one of these recommendations the government does (Ministry of Foreign Affairs, 2021).

Remanufacturing also shows a good example of circularity, where machines used to go to waste when they became outdated does this concept keep these materials into the cycle of materials. According to the principles of the circular economy, waste should be ‘designed-out’.

“A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models” (Ellen MacArthur Foundation, 2013).

This means producing products in a way that there is no need to produce waste and to ensure that each of the materials can be kept in the cycle and thus is circular. Even recycling is something that should be avoided as much as possible. Despite that reuse was something that did not really get embraced by businesses due to prejudices about reuse, insecurities about the economic potential and the addition of value (Innovatie Zuid, 2013). This could be solved when products will be offered as a service. For the using party this releases them from worrying about the economic potential or the addition of value as they are only using the product and not owning to make profit out of it. With servitization the use of the product is central and not ownership or any long term advantages and this could unburden the user.

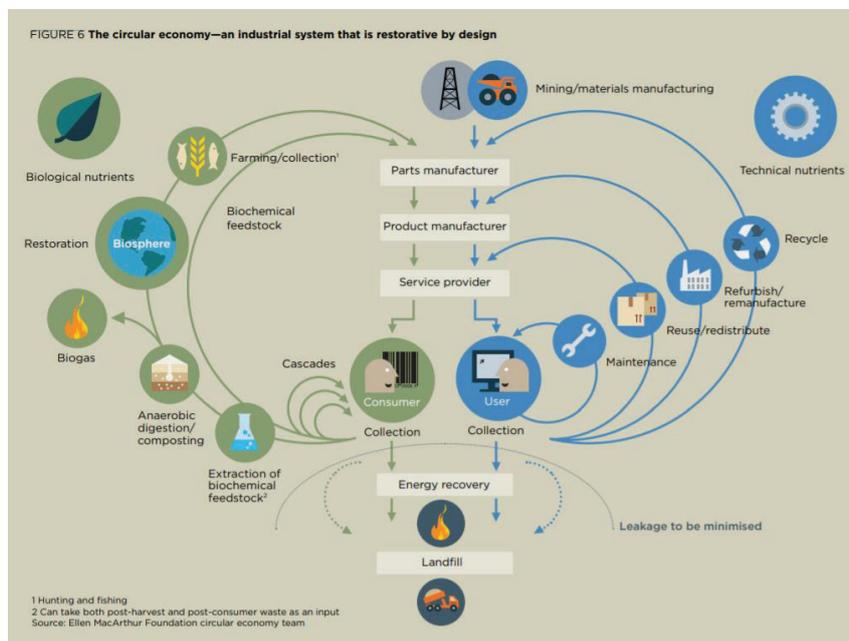


Figure 1: The economy by the Ellen Mac Arthur Foundation (2013)

Figure 1 shows this process of circularity in an industrial context. At the top of the picture there is the input in this system, being raw materials that have been mined or extracted from nature. The bottom arrows shows the waste where sometimes energy can be recovered. The rest of these materials is landfill and that is something that should be minimized. If that succeeds the intention is to minimize the input of materials as well, therefore all the materials should be kept in the cycle to make it a closed regenerative system with zero waste. Another idea that is important is the design of the products. If the products are being designed in a better way there is less effort needed to keep them

operational and the process of remanufacturing could be simplified. The smaller the loop, the easier it is to make them 'as good as new' and more circular means more impact so this should be an incentive for manufacturers to produce their products in a way that they can keep them usable for as long as possible with good possibilities to maintain, refurbish or remanufacture to the highest possible value (Ellen MacArthur, 2013).

Opportunities and barriers on servitization

Organization

Servitization can have a lot of impact on an organization, but it is very important to organize this in a good way where businesses develop business models that can even lead to higher margins. It turns out that investing in such models is rewarding, especially when this has been done in consultation with the specific customer. One of the barriers that PA Consultancy Group (2017) found was that 30 percent of the managers is not sure if they can realize the required behavioral and cultural changes within their company. For decades the main focus of such businesses is on the product and there is little or even zero experience on working customer-focused. Also the sales department will have to change in their way of working. 25 percent of the respondents states that their sales department is primarily product-based and that the selling of a service is much different. Just like the production process does this require a strategy to change in the best way possible. Another consequence that should be taken into account is the financing structure of such business models. A servitized business might need a better liquidity position with servitization as it spreads its income over a certain period of time instead of earning a huge amount of money at once when it just sells the product. When there are unforeseen costs that all of a sudden appear this could lead to problems for the businesses. This shows that the implementation of a servitization requires a significant change across the board to ensure that the business as a whole is striving for the same target, which is providing service.

Costs

Mishra and Shah (2009) describe the three dimensions of servitization, being at organizational, supply chain and operational level and among these three dimensions cost-based synergies should be created in the internal structure of the organization. This helps to create mutual understanding about each other's activities and concerns. Process- and resource-oriented practices can be adjusted to each other and this makes the process function in an optimal way. Development costs, wasteful expenditures of resource and time can be reduced and this creates space for new market opportunities (Mishra and Shah, 2009).

Another cost-related issue is the move from Total Cost Of Ownership (TCO) towards total customer unbundling. With TCO is meant, as the name suggests, the purchase price and the operational costs of an asset, so all the costs that are linked to a certain asset. In the traditional situation TCO formed the costs that a businesses had with regard to a product. With servitization the focus is moving away from TCO towards total customer unbundling. The customer who used to make TCO is going to pay for the use of the product and not for owning the product. From the perspective of the selling party this can be seen as unbundling of the customer. They pay for the use of the product and then the selling party should facilitate this and unburden the customer to give the customer the best experience. The customer will be the starting point and from that perspective choices will be made. Who is the customer, what is the customer doing and how could a company help this customer? This should shape the service and the targeting of a company. A company should start thinking in services if they want to implement servitization.

Customer perception

Elzinga et al. (2020) described the consumer acceptance of new circular business models and concluded that take-back management is the most accepted model, which is basically the producer

taking back the product at the end of its life cycle to reuse, repair or refurbish (Vermeulen et al., 2019) it into a new product which can be produced in a circular way by this. The aim for OEM's is to offer a service according to the needs of the customer. Another issue, which is a challenge for the producer is to convince the customer that their service-oriented business model is beneficial. It has some advantages, which could be services as installation or reparation, and for the producer it is important to underline these extras to attract their potential client (Elzinga et al., 2020). Another remarkable finding of Elzinga et al. (2020) was that ownership is not necessarily very influential in the decision-making process for customers. This is a positive development as this suggest that people are not really focused on owning a product, but that their main interest is just making use of the product. This is in line with the example of Philips that is not selling lamps anymore, but light. This increasing in non-ownership is also visible in the car industry where the amount of private lease cars has grown significantly in the Netherlands (RTL, 2019).

Proposition

Companies have to think of what they want to offer as a service. They were used to selling a product, what do they want to add with their services and what are they not offering? Also relevant is how they will incorporate this service culture in their organization. If the type of service is being determined they should discuss how they are going to develop this service. This is in first instance about the internal structure and capabilities, but also about how to develop this profitable, but also about doing this in a smart way. Circular business model are in essence about sustainability so the aspect of sustainability should also be addressed in the development of a new model. Then the organization and realization of this new structure should be addressed. What needs to change and what has to be accomplished to implement this new model successfully. Then it also needs to be determined which party is accountable for which kind of service. The OEM is most likely be the link that offers the most services, but how is this being settled in the rest of this chain? And what can suppliers contribute to this service? Another important thing to consider is: Who earns from my product? There is a huge chain and businesses should ask themselves where extra value can be created and where extra revenues through service can be gained. When this is being performed in a proper way which satisfies the consumers' needs it is likely that organizations reach a competitive advantage which is difficult to overtake for competing businesses, so that indicates the positive effect of servitization on economic performance (Hao et al., 2021).

According to research of PA Consultancy Group (2017) there is an increasing importance of servitization. About 75 percent of the manufacturing businesses think their sector will be dominated by offering services instead of products within a few years. Despite this, only 30 percent of these respondents was actually working with a servitization strategy in which they chart which market they want to enter, which customer they want to attract and which service they want to offer and how (PA Consultancy Group 2017). These are some significant questions, but apparently most entrepreneurs are aware of the changing market in the manufacturing industry, but it seems like they are not adapting to it yet. According to PA Consultancy Group (2017) businesses who integrated servitization models within their main business model see their margins raise with about 35 percent, so the absence of a strategy can even lead to a loss of profit. It seems like most respondents are not ready for such a strategy or they do not see the urgency yet and think they can stay competitive with a product-based business model. According to Kastalli and van Looy (2013) there is an immediate positive effect on the revenues after implementing a service-model. These short-term gains are being followed by a slight decrease. In the end when investments are translated into economies of scale they conclude it turns out that on the long term servitization is a proper pathway to sustainable growth for manufacturing businesses. At the backside of the company does servitization have a lot of impact. The turnover by service is with production companies usually quite restricted. Servitization requires a streamlined service organization with a deep view on the way the product is being used by

customers to enable customization by the company. Digital developments such as big data can play an important role in adapting to this new situation (CTAC, N.D.).

Competitive position

If businesses want to stay competitive on the long term it is important to tackle the earlier mentioned obstacles. According to PA Consultancy Group (2017) are the average margins on service about 25 percent while the margins on the product itself are below the 10 percent. Another effective addition to the implementation are new technologies. About 20 percent of the well-performing companies use technology to make their offer suit the customers' demands. It also enables businesses to keep control over their product and anticipate on required maintenance. This is essential for a properly functioning revenue model as it supports good functioning product and thus a good service. Despite that it is also important to cooperate with customers and about 70 percent of the well-performing companies does this. Respondents acknowledge that they should make more use of data which can improve customer experience and innovations (PA Consultancy Group 2017).

PA Consultancy Group (2017) concluded that it is important to undertake action and no longer remain standstill. Servitization will be crucial for the future of the manufacturing industry and they think that companies should not ignore this trend any longer. Key is the implementation of a consistent strategy for providing service over each component of the company with a long term strategy about the desired direction. This provides clarity through the whole organization and this can lead to profitable business model that can provide a successful future. In this research this consistent strategy will be measured by five challenges from Martinez e al. (2013) that businesses should overcome to obtain a consistent servitization strategy that can benefit them in the future.

Supply Chain

This research will examine the opportunities and barriers on the implementation of the servitization business model on supply chain level and thus it is interesting to make a perception of this supply chain. Mentzer et al. (2011) describe a supply chain in the following way: "A set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer". Basically this can be applied on every specific context when multiple entities are involved. A supply chain is the process from a raw material to a consumable product and forms the link between the different parties within the manufacturing industry.

Additional is the concept supply chain management. One of the earliest definitions of this process is being made by Jones and Riley (1985): "Supply chain management deals with the total flow of materials from suppliers through end users...".

This is what is meant with the overall concepts of supply chains and supply chain management. The parties in this chain can be described as customer, OEM and supplier. In the end there is also the consumer who plays an important role. How to they relate to each other? Mentzer et al. (2011) described this by three different supply chains (see figure 2) starting with the most easy and basic one, being the direct supply chain which consists of one supplier, one organization (OEM) and one consumer. This is a very simplistic and rather theoretical view as most of the supply chains are more complicated in practice. This more extended view is being shown in the second supply chain which implies also the supplier's supplier and the customer's customer. This extension shows the various forms that such supply chains can have. This even gets intensified with the ultimate supply chain where for instance also financing is being involved and where more interconnectedness has been shown. This third version shows how complicated such supply chains can be, and in practice there are most certainly even more parties involved.

TYPES OF CHANNEL RELATIONSHIPS



FIGURE 1a - DIRECT SUPPLY CHAIN



FIGURE 1b - EXTENDED SUPPLY CHAIN



FIGURE 1c - ULTIMATE SUPPLY CHAIN

Figure 2: Types of supply chains by Mentzer et al. (2011)

In this context it is interesting to see how these involved entities adapt to the new situation, being an servitization based business model. What does this mean for their day-to-day business and what do they have to do to change? As mentioned before at the section about the successful implementation does a supply chain need a mutual understanding and synergy with the operational and the organizational level. This needs to be addressed within each organization, but also with the partners in the supply chain. In the manufacturing industry with lots of high-tech products, it can be assumed that businesses have to deal with lots of suppliers who might even provide only one small component. Sometimes organizations have to deal with hundreds of suppliers and this makes it very complex to make universal agreements with each of these parties.

In the earlier mentioned situation between suppliers and OEM's there can be said that there is a lack of collaboration. Both parties show ambition, but there seems to be no clear vision towards a more circular and sustainable management. More intensive collaboration could help to improve this. Right now it seems that OEM and supplier are working more separately with regard to the final customer. Mishra and Shah (2009) described how an intensified relationship between OEM, supplier and consumer could lead to better performance for the involved organizations during the development of new products. They call this process: Collaborative competence. In this context the servitization business model can be seen as the new product the organizations are about to offer and it is interesting to see if their collaborative competence can be improved as it seems to be insufficient right now. How can collaborative competence lead to a successful implementation of a servitization business model in the manufacturing industry? In the manufacturing industry most supply chains look like the third chain with a lot of different supplier and where the OEM in the middle is the party who gives the demands. For a single supplier this can be threatening as this powerful OEM has the sources to look for another supplier if this supplier does not succeed. This is an issue that will be addressed extra to see if this change of power can be translated into a more balanced cooperation. Therefore there will also be interviews with suppliers to see what their perspective on the process of servitization is.

Theoretical framework

In this chapter the framework will be discussed through with the opportunities and barriers regarding the implementation of a servitization business model will be examined.

There have been published quite some articles on servitization or product service systems (PSS), which is a concept that has a lot of similarities with servitization. The main difference is that the

ultimate result of servitization is being a service provider, while the ultimate results of PSS is just the combination of products and services (Kryvinska et al, 2014). One of the earlier published articles that still has some relevance is written by Tukker (2004). In this article which was merely based on PSS, but despite the earlier mentioned difference it can also be applicable on servitization. In this paper he described a matrix that shows the continuous flow from at the one side product-based towards the provision of service.

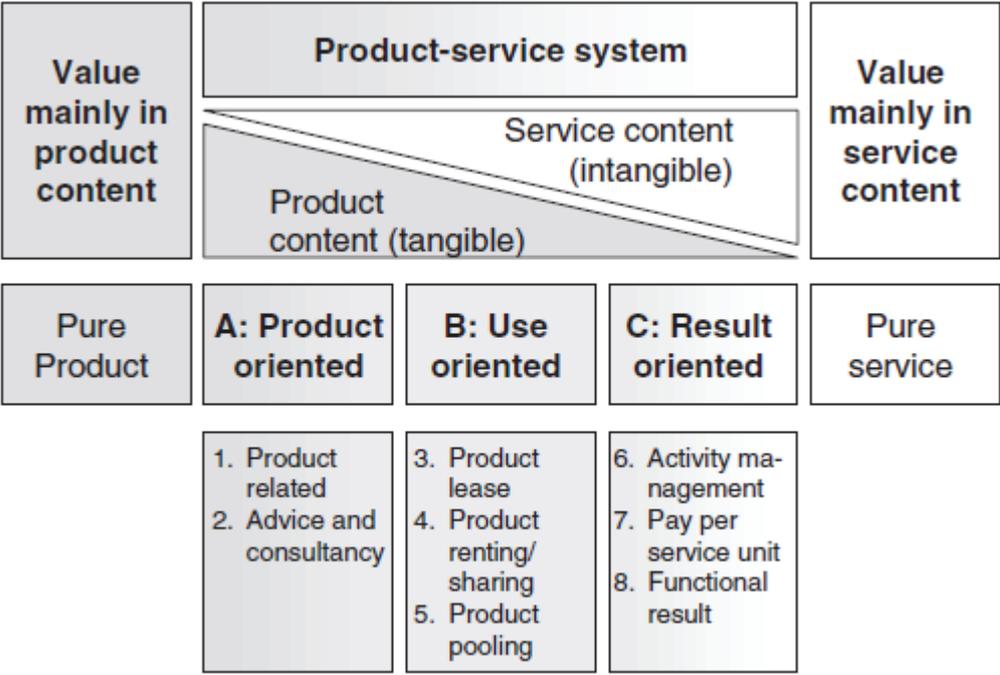


Figure 3: Product-service systems by Tukker (2004)

As can be seen in this framework the right wing of this framework shows the provision of pure service which corresponds with the definition of servitization of Kryvinska et al. (2014) being its ultimate results being the provision of pure service. Tukker identified eight types of PSS and in the matrix can be seen that there is some sort of continuous flow from product-based towards service-based. For businesses that are considering servitization this is relevant, as it shows that it does not become a servitized company overnight, but that is a continuous process where step by step multiple services will be adapted in their daily practices. This can start with providing advices as a service and it ends when, as the matrix shows, the main activity is the provision of service.

Martinez et al. (2009) already tried to make an outline of the five general challenges that organizations in the manufacturing industry face when they want to implement a servitization strategy, being as earlier mentioned:

1. Embedded product-service culture

This challenge underlines the ability of companies with product-service cultures to adapt to the new service culture and develop this towards a sufficient level of service to satisfy potential consumers. When this traditional internal culture is too much embedded in the company, it could hinder the transformation towards an servitization business model. This shows the need for embracement of the new internal product-service culture with much regard for the end consumer, otherwise it could harm the organization. People within organizations, each have their own way of working and routines and integrated offering requires a significant change in employees' mindsets (Martinez et al., 2009). Martinez et al.

(2009) continued that the move from transaction-based working towards relationship-based working involves some cultural challenges, especially from a typical manufacturing mindset that does not initially match the servitization mindset. More interaction with the consumer is needed to match the demands the consumers have in an optimal way. This challenge focusses on the change of culture and will address the 'social' change that servitization brings within a company.

2. Delivery of integrated offering

This earlier mentioned integrated offering entails the way in which this new service should be shaped. There will be a more intensified connection with the customer and this means that more personnel will be involved with the customer than before. In this stage it is also essential that those challenges and issues related to this new service model will be resolved in a fast and fluent way that it does not affect the competitive position of the organization. Synergy between different parts of the organization about the new direction can help to make the organization as a whole more successful. Especially when there are competitors who are not making the switch towards servitization. The organization as a whole has to be aware of the changed situation and they should adapt to this (Martinez et al., 2009). Another potential problem are misunderstandings about the definitions of daily issues in the new situation, such as contracts, negotiations and requirements. How will these things will be addressed in the new situation? Also misunderstandings with the customer should be solved as soon as possible. A clear vision of what kind of service is about to be offered is essential. Organizations tend to focus on the product rather than on the service, so this forms a great challenge.

3. Internal processes and capabilities

The adoption of product-service strategy requires, among others, acquisition of new capabilities that enable the organization to compete in new service spaces (Martinez et al. 2009). Several processes should be aligned into the same direction to make it supportive towards servitization. This could mean that the whole internal supply chain should change. Also certain metrics or algorithms were designed in favor of a product-based organization and this should be changed towards servitization-based metrics or algorithms which makes more sense for the final consumer. Maybe even a change of certain infrastructure is needed to meet the demands of the consumer in a better way to enable the offering of better integrated service. This could be difficult when the knowledge, techniques or other tools are lacking. Requirements related to this should be assessed to provide the company with the best internal structure to embrace servitization. In practice there are issues that could be applied in this challenge, but also in challenge 1 or 2. This challenge will be focusing on actual internal changes that have been made and what these changes entail.

4. Strategic alignment

With this challenge it is meant the alignment of mindsets and understandings towards the offering of integrated services. There should be mutual consensus about what the desired approach will be and how the consumer will potentially be facilitated by the offered service. This involved the common mindset that enables to think like a consumer (Martinez et al., 2009). When everyone is on the same line a better service can be offered and this is profitable to the organization as a whole. Maybe even certain language, related to service offering, should be integrated, but all this helps to make a smooth transformation. There could be even different degrees of alignment where some departments are working more

intensive together they may need to have more things settled in a clear way, also related to the consumer. Some people who have their daily tasks far from the consumer might have less attention for the consumer than employees who are in touch with consumers every day and this could also form a potential mismatch that should be addressed as soon as possible. There might even be a shift of power in a servitization business model. This challenge has overlap with other challenges. What makes this challenge distinctive is its focus on the decision-making within a company and the fact that it shows how businesses look forward to new opportunities in the future.

5. **Supplier relationships** An important issue that has to be managed is the relationship with the supplier or suppliers. The customer will have different needs and this has to be managed throughout the supply chain as a whole as it involves each of their parties. The OEM needs to fulfill a great cooperation with its supporting network to make the servitization process successful. The focus needs to shift from product-based towards service-based and a lot of processes have to be reconsidered to make it fit the servitization business model. In this phase also the division of power is interesting as mentioned in the problem statement. Is the OEM in charge and can it put higher demands towards suppliers and are the suppliers able to join the servitization process? Also the sharing of knowledge needs to be intensified. Information about the service that is to be provided needs to be shared to ensure that each of the involved parties is able to adapt to this. Additionally, the misunderstanding between suppliers and OEM with regard to circularity or sustainability in general should be discussed at this challenge. As mentioned in the above there is no such thing as a mutual understanding about their direction towards forms of circularity. There is a strong preference among different parties within the supply chain to become more circular, but the way this should be addressed and managed is still unclear. As the problem statement shows the OEM wants its suppliers to be more circular and reversed are the suppliers willing to become more circular, but do they feel pressure to meet the demands of the OEM. Can hundreds of suppliers live up to the demands of one OEM and do they have the facilities to do something about circularity besides their daily practices? These two general situations implicate that the mutual trust and collaboration is not sufficient to improve this situation. Parties are waiting for each other and do not exactly know what to expect.

Operationalization

With the earlier described theories and frameworks there will be made a broad and comprehensive outline of the existing literature on servitization with a specific focus on the manufacturing industry. Furthermore there will be made a description of this process and the main opportunities and barriers that occur will be described.

The opportunities and barriers will be tested through the framework of Martinez et al. This will be tested by four OEM's and their suppliers in the same supply chain. Supply chain parties have different components with their own interest, daily activities and related stakeholders. Specifically the mutual relationship between OEM and supplier will be highlighted. This chain will be described by the different elements in the chain.

These general challenges have been mentioned by companies in earlier general research regarding integrating product and the offering of service and it is interesting to elaborate to what extent these challenges also apply on manufacturing companies in the area of Brabant. According to Martinez et al. (2009) do these five pillars form the foundation of the challenges that have to be met in the

servitization process. Just like the paper of Mishra and Shah (2009) the overarching problem was a lack of integration between the different parties with a lack of adoption of servitization practices so it is interesting to see to which extent this is also the case in the parties where the BOM is involved with. Additionally each of the cases can be assessed by the framework of Tukker (2004) to see to what extent service already is incorporated in the organization.

According to the existing literature a servitization business model can be profitable with a positive environmental performance. Further the expectation is that good collaboration among the involved parties with proper adoption of servitization can lead to successful implementation of such models. The aim is to measure this in the next few chapters with some practical information from parties from the manufacturing industry guided by the proposed challenges.

Graphically this theoretical framework looks like figure 4. The input comes from the five challenges from Martinez et al. (2009) that should help to identify the main opportunities and barriers, whereby the fifth challenge will also focus on the mutual relationship between OEM and consumer. The opportunities and barriers form the step towards the implementation of a servitization business model. To provide more insights in the type of services the paper of Tucker (2004) is involved that will show the type of service that is being offered by each of the OEM's.

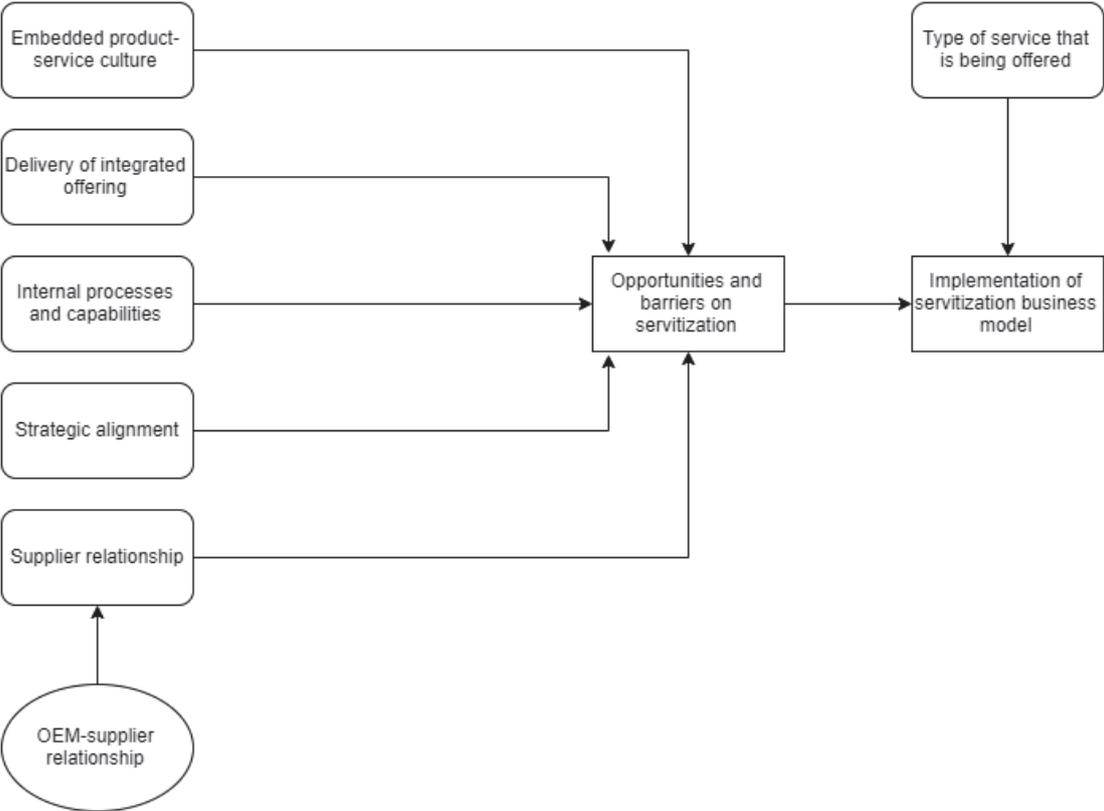


Figure 4: Conceptual Model 1

3. Methodology

In this chapter the research design, the research ethics, the data gathering and the data analysis will be discussed. The research contains the justification of the design and the way the research question will be answered. Then follows the research philosophy in which the choices regarding the validity and reliability of research will be justified. After this an outline how the data is gathered and where the data is coming from. In the end the analysis of the data will be explained. What steps have been made from raw data towards a research answer?

Research design

The aim of this research is to find the main opportunities and barriers for manufacturing companies with the implementation of a servitization business model, with special attention for the relationship between different parties within the chain, being predominantly between OEM and suppliers. For this research four cases from the manufacturing industry have been selected that should help to provide an answer on the proposed questions. The exploratory character of this research enables to view the servitization concept from a practical perspective by semi-structured interviews, with additional the theoretical base that has been provided in the theoretical framework.

The main research question is: What are the main opportunities and barriers for business in the manufacturing industry towards a servitization business model? This research question has a qualitative nature as it asks for descriptive answers that outline the main opportunities and barriers that manufacturing businesses face. As the research question entails this research is looking for factors that influence the successful implementation of a servitization business model. This is tested through the five challenges that will form the framework of this research. Because of the above mentioned issues this research can be defined as an deductive descriptive research (Van Thiel, 2014).

Philosophy of research

This is an interpretative deductive research in which the aim was to identify the main opportunities barriers for businesses to implement a servitization business model. Interpretative because the aim is to try and understand the different variables that involve this case and there are multiple ways to interpret this situation as there is not one true world, but different opinions, perspective and interests. This research tries to reach a certain level of understanding on this topic where a broad literature study forms the foundation after which this literature is tested with respondents in the field. Critics have stressed the risk of double hermeneutics. To minimize this the respondents are cited as accurate as possible where minimal interpretation of the researcher is used. By doing this the respondents' point of view is illustrated in a reliable way. Interpretative research studies the perceptions of the people included in a study, which makes it difficult to determine whether the knowledge acquired is generally valid. Another related objection is that if reality is indeed always subjective, researchers can do no more than give their own interpretation of it. This research aimed to try and get an as broad as possible overview of the research situation by gathering as many data as possible. During the course of research, the researcher detected certain patterns, such as correlated events, which provided an explanation for the phenomenon of interest (Van Thiel, 2014). The main difference between quantitative and qualitative research is that quantitative research makes use of a fixed amount of answering possibilities, while qualitative research has often no fixed questions and respondents can respond in the way they want. To keep the interview on track and make sure there is a reliable set of answers it is important to play an active role as a researcher and make a thorough and comprehensive analysis after to enable to draw conclusions. Of course interpretation and subjectivity still plays a role, but by the earlier mentioned steps the impact of this can be minimalized. On the other hand it is also interesting to make people explain their own answer and that is why is chosen for a semi-structured interview.

Validity and reliability of the research

Another important issue related to this is the representativeness of the data collection. This means that there has to be a sufficient amount of semi-structured interviews to enable the researcher to draw conclusions from it. For example when three respondents have the same vision or opinion, this is more reliable than if only one of them says this. It is also important to create a balanced group of respondents to avoid subjectiveness with people who have the same opinion. The case studies were all from the manufacturing industry, but with bigger and smaller businesses and with different products to avoid competition and to create more variation between cases. Variation in the cases helps to generalize findings and that enforces the external validity that will be discussed in the next paragraph. The amount of interviews depends on the size of the interviews and the people who are being interviewed. In this research four different cases have been selected for an in-depth analysis. As a researcher it is important to stay as objective as possible and avoid guiding questions. On the other hand is asking through also important to create a more embedded and deep body of knowledge with open-ended data. As mentioned before the interviews were semi-structured, this means that some predetermined questions will be asked while the other part of the interview is not specifically planned. This enables the interviewer to ask through and it gives the interview more the characteristics of a conversation when two way communication appears. Based on the research question and the literature some questions were proposed in the interview guide to still give the interview a logical structure. The questions were asked in an open way to avoid steering in a certain direction.

With the earlier proposed questions, the expectations is that this will answer the main question in a way that suits the desired outcome. The main focus is on opportunities and barriers towards servitization and these opportunities and barriers have been divided in five different challenges with the idea that through the framework that these challenges form, the main research question can be answered in a proper way. The quality of the research design is restored by matching the four criteria that define the quality of the research design, three of them involve the validity while the last one is about the reliability. The first one is the construct validity, which implies the correct identification of the operational measures for the concept being studied (Yin, 2009). A sufficiently set of operational measures is needed to collect data in an objective way. This can be done by gathering multiple sources of evidence, making logical and verifiable arguments which can be supported by respondents from the interviews who underline the earlier made arguments (Yin, 2009) This has been done in the literature review and the theoretical framework. In the literature review an outline has been made of the relevant articles to this topic while the theoretical framework shows the way in which the research problem will be approached. With a broad set of respondents there are multiple sources that will contribute to the final findings of this research. The second component that strengthens the validity of the research is the internal validity. The internal validity involves the causal relationships that have been established within the research where certain conditions could lead to other conditions. Thereby it should be considered whether certain established patterns match and if the made causations are correct. In other words, is this research done in a correctly? To guarantee this there has been made a starting point of this research being an outline of the situation with a problem statement. Furthermore some literature about the research problem has been added and with the data that has been gathered in the field this should form an answer on the earlier mentioned problem in a valid and structured way. The third form of validity contains the external validity and this defines the domain to which the findings of this research can be generalized (Yin, 2009). For whom is this research interesting and for whom it is not. This research is mainly aimed at manufacturing companies who are implementing a servitization business model. Servitization is about a product that will be transformed into a service and this is mainly applicable on businesses who make products, thus the manufacturing industry. By selecting organizations who produce different products the aim was to create a more broad set of findings to enable generalization between different sectors, for example the high-tech industry and the kitchen industry. Lastly the

reliability, this is showing that the operations of a study, for example the data collection, can be repeated with the same outcome and results. That means that using multiple reliable sources that strengthen each other complemented by reliable respondents who have good expertise in the field if study would lead to the same results. The reliability helps to minimize errors and biases in a study (Yin, 2009). To ensure and show the reliability proper documentation about the procedures is important whereas almost every operational step that has been made are documented with the use of reliable data. Also respondents with knowledge about the studied subject have been selected to make sure their input is valid.

Data analysis

The theoretical framework tries to suggest a specific answer to the main question raised by the study. Most importantly, then an argument is developed, using different theoretical building blocks from the framework. Therefore theoretical framework provides guidance to this research. It shows what needs to be studied in order to gain an empirical as well as a theoretical answer to the chosen research question. In deductive research, the demands of consistency, empirical accuracy and parsimony have to be met. The application of the theoretical will take place during the next phase of the empirical cycle, which is in chapter 4 (Van Thiel, 2014).

In chapter 2 there has been made a scope through which the businesses will be analyzed. Four cases have been selected, which are OEM's from the BOM network that are working in the manufacturing industry with ambition towards either circularity or servitization. To create some variation each four cases have been selected that produce different products within the manufacturing industry. With each of the businesses a comprehensive semi-structured interview with an employee is conducted to create a deep level of understanding. Besides the four OEM's the aim was to conduct an interview with one of suppliers. This contact is facilitated by the OEM who selected a supplier to conduct an interview with. For a more general view some expert interviews have been conducted as well. These where both internal colleagues at the BOM as external experts/stakeholders who could provide more insights about this topic. By a theoretical framework, supported by literature and interviews there will be trying to detect certain patterns from which general conclusions could be drawn.

As mentioned before this research contains twelve in-depth semi-structured interviews with several experts or stakeholders who gave their insights on this topic based on their own perspective. The following OEM have been selected for the multiple case studies:

- Hapert trailers: This is an organization that is market leader in the Benelux when it comes to selling trailers. Through Europe this organization is known for its high quality level and this is also a company that is motivated to become circular and it is considering a servitization business model to facilitate this. Unfortunately it was not possible to speak with a supplier of them, despite multiple requests.
- Vencomatic: Vencomatic delivers equipment for poultry farmers with the least possible environmental impact and the highest possible animal welfare. They are supporting poultry farmers to become more efficient and to make more use of smart solutions. Vencomatic is a very progressive organization and for that reason they were also interested in this interview about servitization although there were not immediately planning on implementing it. Vencomatic contacted their supplier Van Egmond Group for a second interview. This is a wholesaler who provides lots of materials to Vencomatic, but also to other suppliers. Within van Egmond Group sustainability is an important issue and they are considering what they can do in terms of circularity.
- ASML: This is a well-known Dutch high-tech company that is leader in the semiconductor industry with the production of machines that play a vital role in manufacturing chips. ASML is also motivated towards sustainability and they are already conducting a change program to reduce

their waste significantly and to bring products back in the chain with the highest possible value. It is interesting to discuss what servitization has to offer to them. For ASML it was difficult to connect a supplier so there was a second interview with another ASML employee who was dealing with the supply chain and the returning waste flows. That gave more insight in the supplier relationship.

- Chainable: Chainable is a new start-up in kitchen industry that has servitization already as their guiding principle. Chainable offers circular kitchens as a service where Chainable coordinates the different kitchen components from different suppliers to realize the kitchen as a service for their customers. As mentioned their business model is servitization-based, but it is still interesting to discuss their considerations and see what that could mean for other organizations. There was also an interview with one of Chainable its suppliers who joined their servitization strategy, which is ATAG Benelux. They are a well-known organization in the delivery of kitchen equipment and electronic devices. ATAG Benelux is also a very progressive organization who is also thinking about ways to become more sustainable and their innovation manager gave an insight about that and their relationship with other parties on this topic.

The remaining interviews are with experts about the concept servitization, colleagues at the BOM and professionals who have an intermediary role in this field. The expectation is that altogether these respondents should provide a broad an extended view on the area of study in this research.

| Respondent | Type of respondent | Profession | Length | Date |
|------------|--------------------|--|---------|---------------|
| 1 | Academic | Senior Scientist Circular Economy and Resource Efficiency at TNO | 1:00:47 | June 25, 2021 |
| 2 | Advisor | Senior consultant, Program manager specialized in servitization at Praetimus | 46:44 | May 28, 2021 |
| 3 | BOM colleague | Senior Program manager Ecosystems Development at the BOM | 42:43 | May 26, 2021 |
| 4 | BOM colleague | Senior Program manager Ecosystems Development at the BOM | 58:39 | May 18, 2021 |
| 5 | Intermediary | Project manager Biobased Economy at Province Noord-Brabant | 1:20:34 | June 21, 2021 |
| 6 | OEM | Manager R&D & Manager Projects and Sales at Vencomatic Group | 1:01:10 | May 27, 2021 |
| 7 | OEM | Senior director Reuse at ASML | 35:51 | June 1, 2021 |
| 8 | OEM | Trainee at ASML researching Return Flows of Materials | 45:33 | June 10, 2021 |
| 9 | OEM | Co-founder and CEO at Chainable | 45:45 | May 24, 2021 |
| 10 | OEM | Director at Hapert Trailers | 53:11* | May 21 2021 |
| 11 | Supplier | Commercial director at Van Egmond Group | 34:23 | June 9 2021 |
| 12 | Supplier | Innovation manager at ATAG Benelux | 43:03 | June 22 2021 |

Table 3: Overview respondents *Due to technical errors the audio record of the interview with the Director of Hapert was from poor quality and thus no transcript could be provided. Instead a

comprehensive summary with mutual consent will be added in the attached files between the other transcripts.

4. Results

In this chapter the empirical results will be shown being the output from the conducted interviews which will be presented through the theoretical framework that has been made in chapter 2. First there will be an assessment of the type of service through the framework of Tucker. doing this it gets more clear to which extent service is integrated in the specific business. Then the general results will be presented through the framework of Martinez et al. This contains five challenges and these five challenges help to structure the data that has been gathered from the interviews. The data will be linked to each of the five challenges and this will give more insight in the opportunities and barriers that these businesses face.

Type of product service systems

Hapert is aiming for a lease construction for its customers, which is use-oriented. As an example they mentioned the type of customers they had, which are predominantly gardeners. Hapert mentioned that they are not seeking for a trailer, but for the transport of their own products towards their customers who need a new garden. The use of the product is essential to bring their own products to the desired location. Its customers are not looking for a trailer, but for the transport so the possession of the trailer is of minor importance and that is how they think that this might succeed (Personal communication, May 21).

Chainable can be seen as a company that provides result-oriented services. It is not about the product itself, but about the output it should provide and that is Chainable its responsibility. Their business model is based on the concept of servitization and from the beginning this has been the way they do business. Their main trigger for that is circularity. With servitization they want to change the kitchen industry in a way that it can keep track on the material flows and where waste can be minimized. They see servitization as the best way to achieve this new kitchen concept with zero waste and a circular cycle of materials. At the moment they are a young startup, but when this concept evolves for about ten years the idea is that the materials keep going in a constant circular flow where each material is being used for a kitchen product and that these materials return end-of-life in the supply chain for remanufacturing.

ASML is an organization with a complex capital-intensive product that they export all over the world and this makes a servitization business model difficult. In the first place because of the discrepancy in output expectations of customers and the output expectations ASML has. When there is no agreement on the product that will be offered or the output that can be produced it is difficult to agree on a service contract. What ASML does is providing product-oriented service. They give advice about the computing systems to help their customers to obtain the highest potential output with the highest accuracy. They also offer repairing services so ASML can be identified as a product-oriented service provider.

At the moment Vencomatic is merely a product-oriented organization. They provide a lot of advice on their products, but the product selling itself is still their main priority. They show willingness to shift more to the right on the PSS matrix as they are orientating on the possibilities to involve service more in their business model. They already closed some Service Level Agreement (SLA) and lease agreements, but for now they are still predominantly product-oriented. With their global distributed products, which are difficult to transport, it is more complicated to set-up that kind of service constructions. Vencomatic wants to be an innovative sustainable organization and thus they are motivated to find a way to manage this, but at the moment they prioritize other things, such as advising and consultancy to their customers.

Embedded product-service culture

According to the respondent from Praetimus servitization and the incorporation of it in a business is a long term process that goes by steps and not overnight (Personal communication, May 28).

For Hapert it is not an issue to implement such a service culture. The different departments and facilities at Hapert were already aligned in a sufficient way and this eases the cultural change as the company is in balance. Also the different departments were on the same page and willing to adapt. The standard quality is being extended with circularity and this did not lead to any problems. The director had to convince people that this new servitization model with lease contracts instead of traditional sales can pay itself back. He tries to do this by telling about his positive experiences and by doing this he will try to get his people aboard of this new direction. Also the provision of a reuse department where end-of-life trailers will be repaired, refurbished or remanufactured was not an issue (Personal communication, May 21).

Chainable is a start-up that has servitization and circularity as their basic principles, so the service culture has always been embedded into their organization. Their main focus now is on scaling up to start growing as a company, but also to change the kitchen industry in a positive way and make the product-service culture also embedded in other organizations. They do this by being visible and try to convince other organizations that their way of working is an addition to the kitchen industry, but also to the environment with its circular starting point. For Chainable this also was an advantage of being a startup that not has to change their total internal structure. Some companies do not have any experience with offering service and then it is a big step to enter such markets (Personal communication, May 24).

The respondent of ATAG Benelux describes the broad set of initiatives that are ongoing in the kitchen industry with regard to this topic. At the one side the established names, such as Bruynzeel and Bribus who already have an enormous install base of kitchens in the project business. On the other side there are also new players in the market, such as Chainable, but also the Newmakers who bring new initiatives to the market as small start-ups. They bring new concepts to the market and for ATAG their job is to complement this with the right devices in the most sustainable way possible. ATAG joins these different pilots with different businesses and the aim is to expand these pilots to a regular way of working. This means that they are looking for other parties who also want to take this step. ATAG wants to be known as an progressive organization and thus does these steps not lead to much resistance within the company (Personal communication, 21 June).

For ATAG the switch towards servitization is quite a big step. ATAG is a traditional production organization and switching from selling products to selling a service with lease contracts and memberships is an enormous transition. An example is the financial administration of a leased product. This product stays on the balance while a sold product will be removed. This changes the financial figures drastically and that is something that should be addressed. Despite that they see that this new way of working gets more and more embedded and they are already seeing results that show the added value of this transition towards service. (Personal communication, 21 June).

ASML is trying to design their products in a way to make it fit the re-use change program that they are pursuing. This is a program where they try to reduce waste and in the last year this already led to a significant reduction of waste. This program needs an integral approach throughout the organization where each of the different departments has to integrate re-use in its day-to-day business. This implies the return flows from customers back to ASML, but also the optimization of re-use to reduce waste and to make a re-use product from good quality (Personal communication, June 1). This change program affects the whole organization and requires a new way of working.

At Vencomatic they consider servitization as a process a company goes through. One of the respondents believes that servitization will be the future, but he does not know yet how this exactly will look like. Vencomatic is not actively pursuing a servitization business model, so this embedded product service culture is not the case yet. With regard to other changes within their organization, just like other respondents, they stated that this can lead to misunderstandings and different point of views between the different departments. Vencomatic has an innovative Research & Development department and sometimes their progressive views are not in line with the views of other members in the organization and it is likely that also the implementation of a service model will lead to friction. For the board it is important to manage these issues to make a transition happen smoothly. Vencomatic is a company that gives high priority to innovation and sustainability so they see it as their responsibility to take such processes into account, but not overnight. It is a process that goes step by step and Vencomatic is constantly considering which steps they can take in that direction. At the moment they are not ready yet to guarantee the technical uptime of their products, for now they prioritize other things such as the provision of advice to their customers (Personal communication, May 27).

For Van Egmond the cultural change by adding services to their products is not always easy. The respondent says that change is good, but that nobody wants to change. Sometimes changes are required, but it is also important that the employees support this decision to change and that is a challenge sometimes. Sometimes during new situations regarding to service purchase and selling department are not totally on the same page, but the board of Van Egmond always manages to deescalate this immediately (Personal communication, June 9).

Delivery of integrated offering

The respondent from Praetimus described how servitized environments will lead to more standardized products. Standardized products make scaling up easier for OEM's and the reuse aspect is bigger. Spare parts can be delivered easier and through modularization, customization and standardization can be combined (Personal communication, May 28). This also got confirmed by the respondent, each of them saw potential in the fact that their products are modular designed and this enables the delivery of spare parts and reuse of equipment and extend the lifetime of products. It forms a trigger for businesses to design their products in a way that this can be facilitated.

Hapert has certified retail points and by doing this they can stay close to their customers and try to life up to their demands (Personal communication, May 21). These retail points form the main connection with the customer and they will have an important role in the delivery of this new offering. Instead of selling they will start to offer lease contracts and they will form the link with the service department of Hapert where leased trailers can be repaired. This customer-OEM link should be established from the beginning to make a smooth transition from selling towards service contracts to create maximum satisfaction among customers.

These are some extra issues that appear when you start with such service contracts. For each of Chainable its customers a clear agreement is needed about what kind of service they expect from Chainable. With their business model, Kitchen-as-a-Service, the customer has the ability to choose what kind of service it wants to receive. Chainable offers a few different services and it is up to the customer to decide what offers fits best. A lease contract is possible, but they could also agree on a service contract. For Chainable some important demands are the intention to withdraw a specific component to the relevant producer end-of-life to make sure it can be reused in the highest possible value in the future. This can lead to problems when suppliers do not exactly know what they are committing themselves with (Personal communication, May 24).

Another issue for customer is the fact that a startup as Chainable quite expensive is to join forces with, due to the fact that starting businesses can only borrow funds against a high interest rate. Chainable makes a proposition in which they make the advanced costs and sometimes this puts potential customers off. As an alternative Chainable could sell the kitchen with an repurchase declaration and a service contract to make sure Chainable keeps control of the kitchen and maintain the residual value, but also to keep the whole process circular by repurchasing the different components of the kitchen end-of-life. Also for temporary housing destinations renting kitchens could be interesting with an agreed lifetime of the contract after which Chainable can withdraw and replace the kitchen somewhere else. Chainable can offer different kinds of contract as long as the circularity keeps maintained (Personal communication, May 24).

Chainable's supplier ATAG Benelux is also involved in the service business. They offer especially in social housing in combination with for example Chainable and other housing corporations. At the moment they are doing several pilots with regard to service. One of them is the provision of long term contracts in the social sector in Amsterdam. Every two years they check and provide service on a regular basis to each of the devices to guarantee a long lifetime for their products with the highest possible satisfaction for the customers. They prefer to repair products instead of replacing them, but if they replace the broken parts go back to ATAG for remanufacturing to deploy these parts again in the future. By doing this they connect servitization to circularity, just like Chainable. In general the idea is to monitor the products to keep them operational as long as possible with circular use of components (Personal communication, 21 June).

For ATAG the circular business forced them also to talk with refurbishment and recycling parties how to organize the withdrawing of products to make them operational again, and that is something new and unknown for ATAG (Personal communication, 21 June).

The provision of service is something that ATAG had to think about in the beginning how to offer a low threshold local service in their enormous sales area. They have about 65 service mechanics at the places where they have their products and they can provide service in a fast way, with low efforts for ATAG and the customers (Personal communication, 21 June).

For ASML providing upgrades is one of the services they offer to keep products up to date and they are also able to provide service on location in the countries they are represented. Other services are the guaranteed uptime of a machine, maintenance, Service Level Agreements or work preparations and advice about the best possible use of the machines (Personal communication, June 1).

For ASML it is important to improve their machines every year. They want their machines to obtain higher output against lower costs. This is the mission they set for themselves according to Moore's law. ASML (N.D.) says the following about Moore's law:

"In 1965, Gordon Moore, one of Intel's co-founders, observed that the number of transistors on a microchip was increasing rapidly, exponentially increasing the computing power while decreasing the cost of the chip. Moore predicted that the number of transistors would double every year for the next decade. In 1975, he revised the prediction to every two years. His prediction has proved to be true – or, as some argue, a self-fulfilling prophecy."

ASML offers specifications with their products that shows the technical standard of the machine. Sometimes customers ask beyond specifications and for ASML this does not form a stable foundation to start working on a result-based service level with a fixed output if there is a difference in expectations (Personal communication, June 1). That shows why they will not start with result-based contracts yet.

Pay per use models and the withdrawing of products is not a direct priority for Vencomatic. With regard to their egg-packaging machine they see possibilities in some sort of pay-per-egg construction. Sometimes they also withdraw these machines to sell them further to other consumers, but with their modular stable equipment, which are being transported by ten trucks, they think it is a very difficult logistic operation to manage, also depending on the specific stable. That makes circularity and service contracts complicated. Also because of the fact that Vencomatic sells products all over the world, which makes it even more complicated to bring it back to the Vencomatic factory for remanufacturing. In the past they already designed their products in a modular way to enable this way of working where local malfunction can easily be accessed and solved (Personal communication, May 27).

Vencomatic does offer services like SLA, but their main focus is on adding value to the customer by learning them to work more efficiently with the products of Vencomatic to gain more value from it. Technical guaranteeing of uptime of their machines is something that might become increasingly important in the future, but because of the fact that the machines of Vencomatic are not working 24/7 it has no priority yet (Personal communication, May 27).

With regard to advising and consultancy Vencomatic has a team that travels all around the world to advice customers how to use Vencomatic its systems in the optimal way, sometimes can even help its customers without being there physically. Employees of Vencomatic want to share their knowledge of data-use and smart systems and by sharing this they want to improve the way the customers make use of the products Vencomatic provides. They are also organizing a cloud where positive experiences related to poultry farming can be shared all over the world (Personal communication, May 27).

Vencomatic offers products with a lifetime up to 15 years. They are orientating themselves on the use of SLA, by which clear agreements about annual payment will be made about the service the customers receive. This is more a technical matter, but on the other hand they are also looking at applications where customers can make use of on subscription level. This app will provide them additional information, but also continuous updates on their products. Vencomatic keeps developing every year and by providing updates they can acquire extra revenues out of the same products. End-of-life service is something that they want do dive into in the future. Currently they do not take back nor remanufacture their products and with regard to circularity they are aware that this is something that they have to take into consideration for the future. Right now end-of-life products end up in the regular waste flow of customers and Vencomatic does not offer a similar service. They add that their customers also tend to use their products as long as it is still working and that this might be beyond the economic or even the technical lifetime, although this is also sustainable somehow. In this sector it is not that bad if a machine has a breakdown. Most users have spare parts which they can fix by themselves and if the machine works within a few hours there is no problem. These are the regular farmers who pay for the products, but there are also investment companies who want to pay for the cost price each day and they are willing to agree on a fixed contract to ensure their output and to avoid sudden big expenditures. (Personal communication, May 27).

Vencomatic has dealers who sell Vencomatic its products together with additional products for poultry stables as Vencomatic does not facilitate the total stable equipment. These dealers are also the first contact of customers and they facilitate also the first service line as it may be very urgent sometimes with living animals. Vencomatic sells all over the world and they cannot facilitate direct service everywhere although they hey do have some sales managers on location who can represent Vencomatic. This is also the person who also takes the customers' requirements and pass them on to Vencomatic, also with regard to potential service contracts the customer might be interested in (Personal communication, May 27).

Van Egmond Group sells a broad range of products as a wholesaler and are the main contact point for their customers, such as Vencomatic who can buy their materials at Van Egmond. They try to build a service around their products and meet the needs of their customers and unburden them in an optimal way, being primarily other businesses as Van Egmond works business to business. Van Egmond wants to obtain maximum customer delight with providing different kind of services. On a product level Van Egmond is easy to replace, so by adding services to their products they try to be distinctive and this also unburdens their customers. They do this by packing their products in the desired way or by already assembling components in favor of their customers to reduce the amount of spare parts. With these added service Van Egmond wants to build an intensive relationship where customers are likely to return (Personal communication, June 9).

Internal processes and capabilities

The respondent from TNO says there is a lot of potential to improve with regard to the internal processes. He mentions more efficient time planning, spare parts management and the customer relationship as important areas and he noticed a certain awareness that servicing can be rewarding in combination with new technologies and innovations (Personal communication, June 25).

The expert of Praetimus described that extending the life cycle of a product, selling second hand equipment and providing upgrades are opportunities that business could incorporate in their daily activities (Personal communication, May 28).

As mentioned before Hapert already had internal processes that were eminently suitable for a servitization model, because of the modularity of it. The quality of the product was already on a high level, so that makes the offering of repairing easier, as less repair is needed. Hapert tries to stay up to date and move with the times. Hapert is known for its high quality trailers and this shows that their internal structure is on a high level already. With offering lease contracts it is trying something new and they had to mobilize some knowledge to do this. Hapert also tries to incorporate circularity in their new business model. By offering services the lifetime of the product can be extended. Besides that they also take back their trailers after five years. In the past trailers got dumped after 10 to 15 years. In this new construction the trailers will be taken back and refurbished after 5 years and then they can sell their products again. With an extra refurbish and remanufacturing department Hapert wants to manage this new direction of servitization and circularity (Personal communication, May 21).

For Chainable their internal structure was always aimed on servitization. Chainable is young start-up whose aim always was to create a circular kitchen based on a servitization model. They want to change the kitchen industry and inspire others to do the same. Chainable is the leading organization with other businesses delivering kitchen equipment and this role requires them to communicate and to facilitate on a high level (Personal communication, May 24).

As a young start-up with a vision that is based on servitization and circularity everyone is likely to embrace this vision within Chainable. Chainable is acting as the link between the different parties who produce the required products or materials for their circular kitchen. In first instance to produce the circular kitchen, but when the components of these kitchens have to be replaced Chainable also makes sure they are being returned into the supply chain to enable the producers to make the products usable again, and by this the kitchen stays circular. They made their suppliers figure out what their highest waste stream was. Most suppliers named materials like carton or plastic and did not realize that also their products will be waste in the end. Chainable triggered the different parties to think about this and by doing this could come up with a strategy how this could be improved by circularity. (Personal communication, 24 May).

The respondent of ATAG sees that there are some internal struggles between the interest of on the one hand the purchasing department and on the other hand the sustainability department (Personal communication, 21 June). For businesses it is a challenge, especially in bigger companies, to make these different departments work in a mutual way where they also have mutual interests and during a transition from product to service this is something that requires attention. Despite that ATAG has several products who are suitable for servitization, due to the high attachment of the products. ATAG delivers high-quality products where people take good care of and for that reason they are more tempted to take a service contract to guarantee the functionalities. Another advantage is the fact that ATAG its products are easily repairable and that is also something that fits the idea of servitization to extend the lifetime of their product. ATAG has a complete organization that enables switching to new ways of working in a efficient way. Also the service department that is already operational with its own logistics shows that ATAG has a proper internal structure for such transitions (Personal communication, 21 June).

By working together with universities and other knowledge institutes ATAG tries to mobilize knowledge about circularity and new business models in its organization, but also for its partners and network (Personal communication, 21 June).

When Vencomatic wants to start with servitization they might need to organize this with their local dealers as this requires quite an internal, but also an external reorganization. They need to create a platform for this and the systems need to be organized in a different way. Another issue is the pricing of the services Vencomatic offers. Right now they include several services with their products and the customers are used to that, but within a more servitized organization such services need to be priced as it is part of their business model. Customers are used to the free added services and Vencomatic is thinking how they can price these services without losing the business because of that. They want to bring structure in their servicing and price the services they offer in a clear way. (Personal communication, May 27).

Vencomatic is also involved with the local educational institutions where they invest in proper guidance in their organization. Vencomatic has employees who are fulltime thinking about new innovations to stay competitive and innovative and they have some budget that acquires them to think outside the box. Sometimes this can conflict with their sales department who only think about the present, but Vencomatic invest significant to stay innovative over years. With the universities and within their local network they also see what other companies are doing and this enables them to learn from each other and discuss how new innovations could become a business model . (Personal communication, May 27).

Each of the respondents does value the availability of a network with colleagues, but also with organizations from other sectors. They can learn from each other's best practices and it shows that not everything has to be invented by an organization itself.

Van Egmond was already providing extra services to their customers for a long time, but just like Vencomatic, they did this for free. Now they want to earn revenues from the provision of service, so therefore they have to start asking money for their extra services and that is change of attitude for them. This the extra revenue possibility that servitization offers. Customers where used to the extra services and now they have to pay for it and this was difficult to arrange sometimes, for example during transport at night. Van Egmond also has a knowledge center that aims to help its supplier and this is an example of an already benefitting service and they want to follow this structure with the services they add to their products (Personal communication, June 9).

The internal structure of Van Egmond was already on a high level and they want to improve this by standardizing internal processes to make the process of purchasing and selling more efficient. They were certified to provide extra services and they can easily adapt to new services if the customers asks for that (Personal communication, June 9).

Strategic alignment

According to the TNO researcher an important question that organizations should ask themselves is: "Who is earning from our product?". Also important to know is what the total cost of ownership is, how does the product creates value and where extra growth can be gained? When these issues are cleared it turns into creating a strategy regarding the deployment of the product and to create a revenue model around the servicing of it. Servitization enables to earn revenues over a longer period with an annual or monthly income instead of just selling. On the other hand it is also a threat for the servicing party as they still have the product on their balance with the associated risks (Personal communication, June 25).

Based on his experience the Praetimus employee defined four lessons he learned that are important regarding a servitization strategy. Firstly define your vision and goal, which should be stretching, but also realistic. Second step is making a roadmap which involves a plan how to reach the goals. Third is making sure you have an 'able and winning' team, which means a team that wants to change, but also has the ability to change. And his last lesson was having the fuel or sources to succeed, being money, but also performance and knowledge. He also mentioned an important detail with regard to the strategy regarding transformation. He thinks that businesses should see becoming servitized as a transformation and not as a pilot. Pilots are less thorough than transformation and might end up in the so-called 'pilot purgatory' with a minimal impact while transformations can lead to a long term sustainable advantage when executed properly. He added that organizations should transform by steps. First by setting goals and then start thinking about the required step to reach their goals, being profitable through servitization in this context (Personal communication, May 28).

Product-wise the Praetimus respondent thinks that commodity products, so the more daily products, are easier to servitize than more exclusive products that for example ASML and Vencomatic provide. Commodities are products that are easier to standardize and where the service is most important. Concepts like phone subscriptions and Swapfiets are examples of commodities being offered as a service and by servicing also the lifetime can be extended. This fits the narrative that Hapert and Chainable are already pursuing a strategy into the direction of servitization as they also provide an everyday product (Personal communication, May 28).

For Hapert their choice to start with servitization was a combination of starting on time to build up a competitive advantage and idealism. This has happened after a reorganization found place in the management team (MT). Now there is a MT with a mutual future-oriented vision and this helps to make broadly supported decision that fits the current direction Hapert takes (Personal communication, May 21).

Hapert has a product that is suitable for servitization and this make the decision-making in this direction easier. Due to the fact that they also learn a lot from fellow colleagues in other sectors that are making similar transformations, Hapert has a lot of interesting insights that they can apply in their own business (Personal communication, May 21).

The main trigger for Chainable is zero waste and bringing a positive change to the kitchen industry. In more concrete words they want to deliver 10.000 kitchens in 5 year with annual growth. By investing in this concept Chainable hopes to achieve a competitive advantage at its competitors where they

might start to feel the urgency as well to think about this concept. The respondent thinks that the main difference between the proposition of Chainable and competitors is Chainable having a complete proposition where servitization and circularity is totally embedded while other organizations only try to incorporate circularity (Personal communication, May 24).

With rising raw material prices this is an opportunity for business to improve their competitive advantage. The CEO of Chainable is convinced that circularity can form a very profitable alternative with the threatening scarcity in mind. When products are being returned in an organized way it can make a difference for companies who make a lot of costs for recycling their materials. Chainable takes the products back, zero waste for the customer, and Chainable makes sure the product goes back to its producer who can start remanufacture to bring it back into the market. Especially when this concept evolves for like twenty years, a closed cycle can appear where no input is needed and no output is being produced and this forms a better case on the longer term (Personal communication, May 24).

ATAG has a top-down approach regarding decision-making and the board advocates this circular way of working with service contracts. They discuss this also with the rest of the organization and by doing this they try to obtain more and more support for this direction. They also try to involve the rest of the organization in this decision-making by involving representatives from different departments. Further the representatives do also report to the board so they know exactly what is going on and this leads to more support through the organization. What they want to achieve is a certain market share in the provision of kitchens as a service. With partners ATAG discusses the transition from selling price towards total cost of ownership. In the traditional situation people would buy a product and this product would be replaced after six years without any servicing. Now there will be more consideration for all the costs related to this product and then there could be an agreement with service on a regular basis that could extend the lifetime of the product significantly with advantage for both parties. This is the desired direction for ATAG and they try to involve their partners in this. The most important goal is to be 100 percent circular on the long term and servitization can help with that (Personal communication, 21 June).

For ASML the intention is to give all materials from all modules that are not usable anymore a next life in the highest possible value level Ellen MacArthur Foundation described (2013). They want to remanufacture, refurbish and re-use products that would normally go to waste and bring them upstream to the highest possible level, with the same quality and reliability that it can be used anywhere. Their goal is to have 95 percent less scrap in 2025 with the same output and maybe even better performances (Personal communication, June 1).

ASML takes full responsibility for their own product and in essence they do not talk with customers about suppliers of ASML. ASML has the service pool parts and modules and they manage this and they also want to take care of the provision of spare parts, repairing and other services. ASML will lead this business, be distinctive and compete by offering sufficient quality for a good price. ASML has older machines from which customers accept other service levels. On the other hand does ASML also have their newest machines with the newest technology and the highest performances. ASML wants all machines to function in the best possible way. Customers can choose their own service level from ASML (Personal communication, June 1).

The vision of Vencomatic is that they want to make the world more sustainable. In their context they want an egg to reach the finish line with the least possible waste or pollution. They did extended research on this and various ways to optimize this process. What they see is that 80 percent of the

production companies in this sector could perform better. What Vencomatic wants to do is to help their customers to increase their revenue with the tools and knowledge that Vencomatic can provide. This can be done in terms of data-use, making more use of smart systems and making their system more efficient. In the end their goal is to facilitate a complete autonomous smart stable in ten years. Efficiency is one of the two reasons for Vencomatic to strive for better use of data and technology. The other reason is that they want to close the gap between at the one hand the top poultry farmers who make already use of these tool. And on the other hand the middle class poultry farmers who do not manage to gain the same output with the same number of livestock feed, but with less knowhow about efficiency and the use of smart systems. Their ambition is to create an equal playing field for each poultry farmers and they to this by providing knowledge and sharing experiences (Personal communication, May 27).

Sometimes it is difficult to get each department on the same page at Vencomatic. There is a R&D department who is about three years ahead of the rest and they ask themselves why the rest of the organization does not follow, while the rest of the organization ask themselves what this R&D is doing and why is that relevant for us? They think it is important to manage this in a way that this process goes fluently and then also a concept like servitization can be integrated in their daily practices smoothly and in a gradual way. An organization needs pioneers who trigger and motivate organization to change in a positive way. And the respondents recognize that despite the resistance, most of the times the changes affect the organization in a positive way. They need these pioneers to pull people out of their comfort zone and that helps the organization to stay flexible and innovative without causing division within the organization (Personal communication, May 27).

The main strategy for Vencomatic is adding value and being important with regard to sustainability on a global scale. Population is growing and relatively to cows and pigs, chicken are quite sustainable, they say. For Vencomatic the ambition is to make the poultry systems more efficient, more output with less input, and production in a sustainable way. The respondents describe the 80/20 rule in which they think they can have more impact by helping the poultry farmers to work more efficient, more sustainable with more revenue than taking back products after 15 years end-of-life and that is why they prioritize this as the relative impact of this is much bigger than the remanufacturing of products once in 15 years, but for the future it is something they are going to address. (Personal communication, May 27).

Van Egmond sees service as an extra tool to earn revenues. They offer rather simple components where they cannot add much value, but with service they think they can provide this extra value to their customers. They see service agreements as a way to arrange more long term relationships with customers to generate a constant flow of revenue through their products with added services (Personal communication, June 9).

Regarding circularity Van Egmond is, despite the ambition, still in an early phase and they see it as a future opportunity. Right now they feel that their market is not ready yet and they also know an example of a partner who tried to implement circularity which did not work out. Van Egmond is looking for ways to improve regarding sustainability, such as solar panels and they already have electric trucks and are certified for working according to CSR. Van Egmond its parent organization Sonepar does also encourage this and thus it is from high importance for Van Egmond. Despite that actual circularity is still difficult to arrange within their chain (Personal communication, June 9).

Supplier relationships

An important issue that has to be managed is the relationship with the supplier or suppliers. The customer will have different needs and this has to managed throughout the supply chain as a whole as it involves each of these parties. The OEM needs to fulfill a great cooperation with his supporting network to make the servitization process successful. The focus needs to swift from product-based

towards service-based and a lot of processes have to be reconsidered to make it fit the servitization business model. In this phase also the division of power is interesting as mentioned in the problem statement. Is the OEM in charge and can it put higher demands towards suppliers and are the suppliers able to join the servitization process? Also the sharing of knowledge needs to be intensified. Information about the service that is about to be provided needs to be shared to ensure that each of the involved parties is able to adapt to this.

Hapert recognizes a lot of willingness to cooperate with their suppliers. Because of the size of these suppliers Hapert does not have a lot of power and their ambition is to gain more power in this supply chain context so they can be more decisive. This is also important when they want to implement their new servitization strategy. They are depending on their willingness to cooperate, but they are not really able to influence that. The director added that their cooperation was very positive (Personal communication, May 21).

As mentioned, Chainable is a startup and when they started they did some market research after which they started to approach potential partners from their network if they wanted to cooperate with this new concept. They explained their thoughts in special workshops. Chainable already predicted an expected building volume with an expected moment when the components return end-of-life, and their partners could decide whether they wanted to join or not. For some of these partners it was one of their first experiences with such new business models, so they got some time to figure out how to implement this. Chainable formed a good incentive for them to take the first steps into this direction of circularity and when this proceeds, the cooperation could be intensified with an declaration of intention after which the first kitchen can be made (Personal communication, May 24).

For Chainable some important demands are the intention to withdraw a specific component to the relevant producer end-of-life to make sure it can be reused in the highest possible value in the future. This can lead to problems when suppliers do not exactly know what they are committing themselves to. For Chainable it is important that suppliers take back their products to keep it circular. When suppliers do not want to remanufacture or refurbish their products Chainable looks for other parties who do want end-of-life products to make them good as new. Chainable embraces the idea that products are being kept in the chain. Because of the fact that Chainable is a very young business they did not take back any products yet as most products have a lifetime of at least ten years, but for the future they want to make strict agreements about the retrieving of products and the costs of it (Personal communication, 24 May).

Chainable does not see itself as a powerful player in the chain. Their CEO described them as the conductor of an orchestra. They manage and control, but more from a point of sharing their vision and being transparent to achieve this vision, not to have the power (Personal communication, May 24).

ASML is as the leader of their chain demanding towards its suppliers as they work with the concept Quality, Logistics, Technology and Costs (QLTC). This is a quality monitor which implies that they ask a certain level from their suppliers for each of these aspects to guarantee top-level performances for their products. They have expectations, but they are also willing to help and stimulate their partners to reach the highest possible level for their products as it benefits everyone. Since 2013 they incorporated the S from Sustainability as ASML wants to take its corporate responsibility as well (Personal communication, June 10).

ASML wants to organize its re-use, repair and remanufacture as much as possible with its suppliers. They want each supplier to learn how to repair, upgrade or remanufacture its own module. ASML

built repair centers to build the competence to do this and when they have mobilized this knowledge they share it with suppliers so they can re-use repair or remanufacture their own products. ASML is not the one that produces the modules, they only assemble, so they also want the repairing processes to be with the parties that produced the specific product with supervision of ASML (Personal communication, June 1).

Vencomatic has about 300 suppliers with about ten suppliers who cover 80 percent of the supplies. They have their own production facility for steel, and the steel supplier is one of their main suppliers. Vencomatic did not manage yet to involve suppliers in concepts like servitization or circularity. They are orientating if suppliers might be able to take back materials, but this is something that requires more effort. There is one supplier with a climate system with whom they reached an agreement on the withdrawing of rest materials, but also the product itself end-of-life. This is also something they want to address next years at other suppliers. Right now there are the earlier mentioned challenges that they prioritize (Personal communication, May 27).

Vencomatic forms a serious party and with their biggest suppliers they already have some agreements. They see that the world is changing and they expect that in a few years their supplier cannot longer avoid to take back their products if they do not want to. The respondents think that this linear way of working is ending and that they should think about how they want to facilitate this more circular way of working, also with their end-consumers. In some sectors this goes faster than in the agricultural sector, but also in this sector it will not much longer be accepted that people just dump their waste. They expect that, just like the average consumer, that the manufacturing industry will also work towards structures like waste disposal fees to pay for the disposal of their products. For those reasons they cannot longer avoid to think about it and working more circular with remanufacturing can form a great affordable solution on the long term (Personal communication, May 27).

The respondent of Van Egmond did not notice much urgency at its suppliers regarding concepts like servitization, especially at more smaller parties who produce materials for Van Egmond. Van Egmond tries to involve their suppliers by offering certified training sessions to suppliers. They want to share knowledge to improve also other partners through the chain as this would benefit everyone. (Personal communication, June 9).

ATAG thinks about some sort of deposit system where customers of ATAG return their products against a certain price. This is an extra incentive to keep the material-use circular. ATAG wants its customers to know that they can always return their products to them to enable remanufacturing (Personal communication, 21 June).

ATAG works primarily business to business and their customers are mainly kitchen stores or kitchen builders, but also online shops such as Coolblue or Bol.com. ATAG does not deliver directly to the final consumer, but they still try to focus on their wants and needs by doing research about the desired functionalities of the kitchen devices by final consumers. With the OEM that ATAG sells to they have good contact where they discuss possible improvements, such as more sustainable material-use during packaging of the products. ATAG values this input from their customers and tries to help solving them as their customers are very important to them (Personal communication, 21 June).

For ATAG working with different types of customers, being established kitchen parties, but also new start-ups, is very informative. Right now they are facing new concepts, for example from Chainable, and this is something that ATAG likes to see. They meet very fast new organizations from which they

learn a lot. ATAG is a progressive top-down organization which is always open to a conversation about topics like this and they like to think about solutions for new situations. That is also why they are involved in new concepts like Chainable's (Personal communication, 21 June). They see demanding OEM's not a burden, but more as an opportunity.

Van Egmond is depending on its customers, being big players like Vencomatic, but also Siemens. They are market leaders and according to the respondent, the only thing Van Egmond can do is listen to their demands. He already mentioned that a wholesale like Van Egmond is easily replaceable, he added that they are not really willing to adapt to issues at Van Egmond as they can easily purchase the materials somewhere else. Van Egmond has to work very hard to avoid this, but it is very difficult sometimes to live up to the demands (Personal communication, June 9).

5. Conclusion

The main research question of this research is:

- What are the main opportunities and barriers for business in the manufacturing industry towards a servitization business model?

To answer this question, this multiple case study examined four different cases with each of these cases having its own unique characteristics. This led to a broad set of responses and outcomes, but also provided multiple mutual views on the concept servitization. In this conclusion the cases will be compared, based on their views on servitization, the opportunities and barriers related to servitization with emphasis on the OEM-supplier relationship. In the end also an outline about the case its approach towards circularity will be involved. The respondents were to a different extent familiar with the concept servitization. Chainable's business model is service-based and therefore this concept is already fully incorporated in their organization with their Kitchen-as-a-Service concept. Hapert was in transition towards becoming a servitized organization as they were about to switch towards offering trailers as a service with lease contracts. ASML and Vencomatic were not that far yet. They saw the opportunities servitization had to offer, but were not actively pursuing a strategy towards it yet as they had other priorities, being minimizing waste for ASML and advising its customers and make them work in a more efficient and sustainable way for Vencomatic. Now there will be an overall comparison and analysis about the topics that have been discussed in the results after which the research question can be answered and a recommendation for the BOM can be made.

There are several issues that have been discussed that can be appointed to more than one challenge. A culture change does also have its impact on internal procedures and when an organization is about to offer their product as a service there is very often an underlying strategy that has been implemented through the organization. This made the categorization from each of the topics more difficult, but it also shows the interconnectedness of the different challenges and how they relate to each other.

Embedded product service culture

Multiple respondents stated that change of culture within an organization requires time and effort, especially in convincing employees or team members that need to adapt to the new situation and the new way of working. Synergy between different departments in an organization are required to gain advantage from this new situation. This cultural change requires good management and argumentation to convince people that this is the right direction. There is a difference between businesses with a deep-rooted internal culture and new start-ups like Chainable who do not have to deal with embedded norms, values and practices. They can build from the bottom without any resistance from this existing culture and that is a difference with the other cases who had to deal with a change of culture.

Delivery of integrated offering

Something that businesses should consider is the pricing of service. Vencomatic and van Egmond mentioned that they already added service to their regular sales and with servitization the idea is that services are profitable. Switching from adding extra services towards an actual revenue model is a burden for businesses, but that is exactly the added value of servitization as it enables to gain extra revenues from the same product. Lots of businesses already add services on a voluntary basis and they need to cross this threshold and start asking money for it, despite the resistance of their customers who profit from the free services.

From high importance is the perception of the customer regarding service models. This research has diverse cases with different customers which makes generalizing difficult. Hapert delivers their trailers a lot business-to-consumer, but also business-to-business being predominantly gardeners. Each of these parties has to adapt to this new situation with leasing trailers and Hapert should try to make this new situation satisfying for every customer. Consumers have other using patterns regarding trailers than businesses so they might have different points of view concerning the service concept. ASML delivers their high-tech chip machine makers solely to other big companies. These are different products from a total different price range. Despite that it is important for each of the organizations to take up the demands of its customers to provide an optimal service. With regard to the consumer most of the respondents state that they want to satisfy and unburden their customer as good as possible and that they try to find the service that fits them best.

Another kind of services that can be offered is the upgrading of products to keep products up to date. Especially for the more capital intensive products where new updates can make the machine perform in an optimal way again. In other industries such as the kitchen industry people might be done with products after a while when better alternatives are available. It helps to extend the lifetime of a product and the customer stays satisfied with the newest configurations to their product.

Internal processes and capabilities

A traditional manufacturing company manufacturers new products using raw materials and does not have any return flow of materials, which is the linear model. With the increased attention for circularity and service, businesses have to think about this for the future. How to they want to arrange and manage this return flow and do they have the sources to facilitate this?

Regarding the internal processes each of the respondents mentioned that their internal structure was already on a high level and different departments properly aligned. Processes were running smoothly and the respondents were satisfied with the way their company performed in general. Despite that was becoming increasingly service-based a bigger burden to some respondents than to others, for example because of the type of product that they produce.

A common characteristic for each of the respondents was their product being built in a modular way. This is one of the principles that provides possibilities for servitization and circularity as it makes it easier to repair, remove and replace parts of the machine. In general the designing of the product is something that could simplify the transition towards servitization and circularity. ASML, for example, is putting much effort in the redesigning of their products to make it more suitable for remanufacturing or refurbishing.

Product-wise there is a difference in possibilities with regard to the product itself and the distribution of it. As mentioned do Vencomatic and ASML have a product that is difficult to transport that is being sold all over the world while Chainable, ATAG and Hapert work more local, although still all over the country and abroad, with a product that is more easy to transport. This makes it also easier to provide service on location and that does form an advantage for them. Especially for companies who work overseas it is difficult to install a proper service department in the specific country, especially when there is only a relatively small amount of customers and sales in that area. For Hapert, who is the market leader in the Benelux, and Chainable this is more easy to facilitate than ASML and Vencomatic, who sell their product all over the world. Another advantage for Chainable and Hapert is their product being more a commodity than the products of ASML and Vencomatic. Commodities are basic products where the use of it is important and where standardized products can be provided,

while the opposite are the capital-intensive customized products that Vencomatic and ASML provide and these are more difficult to servitize.

Strategic alignment

Most respondents stated they were in a top-down organization, but with representation from each department in the board. By doing this they try to create alignment over the organization as a whole and create a mutual understanding about the direction to follow.

When organizations think about remanufacturing or reuse as a service they also have to think about how they will execute the repairing and remanufacturing and bring the product back in the highest possible value to save raw materials and to extend the life cycle of products. Setting up a re-use/remanufacture unit is complex and difficult to organize, especially for complex products, but also for smaller businesses with more everyday products it is expensive to manage this, due to logistic and financial issues. From the beginning Chainable has discussed this with their suppliers. If they want to join they also have to take back return flows to remanufacture, because of the circular vision of Chainable. When they did not want to comply with this Chainable went looking for other suppliers. This shows the powerful position they are in. They can offer a company a proposition and when they do not immediately agree Chainable is confident to find another partner, which also underlines their strong position, they offer their proposition, but when businesses do not want to fully agree they just start looking for other partners. ASML is also busy with reducing waste and the reuse of materials. For businesses like ASML it is also easier to build an extra reuse department because of their enormous financial possibilities. This is something that smaller organizations, for example suppliers, do not have. For that reason ASML does the research and development for this reuse department by itself and does it share this with suppliers to make it beneficial for everyone. They are even developing knowledge and competences that they will share with their suppliers to enable them to remanufacturing their own modules. Vencomatic is currently predominantly busy with sharing knowledge with their customers regarding sustainability and efficiency, and circularity or servitization is not their priority yet, although efficient material use is a good start. Vencomatic has their customers located all over the world. Furthermore the stable equipment they offer is complex which makes it difficult to transfer and thus the returning of materials in a circular way. Hapert is starting with lease contracts where they take back their trailers after its economic lifetime to remanufacture it and they will also become servitized and circular.

Some respondents said they had an advantage by networking, sharing and learning from other businesses' or universities' best practices regarding this topic. When it had to do with competitors in the same market it was more difficult, but in general each of the respondents mentioned that they learn a lot from other organizations' successes, but also the mistakes. It gives a view about what others are doing and then they can see whether they are ahead or the opposite and this can lead to action.

Supplier relationship

The OEM-supplier formed an important objective during this research. Is the supplier being bounded by the OEM or does the OEM have unrealistic expectations? It seems that the bigger the OEM, the less personal their relationship with their supplier is. Given the number of suppliers this is not surprising. ASML, for example, has thousands of suppliers and building a relationship with each of these parties is complicated. The same does account for Vencomatic. These are two organizations with an expensive product with a global distribution and to arrange this they should also be demanding towards their suppliers. ASML, who assembles the different materials from suppliers to finalize their chip machine maker, takes responsibility for its own product and does not facilitate contact between customer and supplier. They want to stay the leading organization within the chain

and this does also account for return flows. ASML is responsible, but this also means that they expect optimal performance from their suppliers so they can fulfill their potential and do not have to apologize to customers. They do discuss with their suppliers, but when they cannot live up to ASML its expectations they are forced to replace them as they strive for the maximal performance.

Chainable and Hapert on the other hand, are smaller parties. Chainable is a start-up who is building a network and tries to convince kitchen equipment suppliers to join their concept. One of their supplier was international organization ATAG Benelux and this leads to a total different relationship as ASML and Vencomatic do have with their suppliers. ATAG is a progressive organization that is open to new initiatives such as Chainable with their circular kitchen, and thus they are willing to cooperate, but the relationship was balanced and constructive and there were no unrealistic expectations or burdens.

Van Egmond, wholesaler and supplier of Vencomatic recognized this situation where they have to live up to the demands of their customers, which are primarily OEM's. This was primarily due to the fact that Van Egmond is easily replaceable. When they refuse to deliver in the way the OEM wants, there is a chance that the OEM will start purchasing its materials at another wholesaler who is willing to live up to their demands. This is also why Van Egmond is offering extra services as they want to be distinctive and constructive to their customers. The respondent recognized the pressure and said that they try to give resistance sometimes, but sometimes it is difficult to manage for them.

Discussion

The respondents also seemed eager to start working more circular as they see the long term possibilities, but also the urgency. Each of the respondents said that their business was constantly trying to innovate with new technologies or practices to stay competitive over time. There was a difference between Chainable who is already working circular and some other respondents who were ambitious in that direction. As mentioned this can be combined with the concept servitization. Becoming servitized enables companies to extend and intensify their customer relationships. Companies used to sell products and now they can gain extra income by providing service and by taking back end-of-life products that used to go to waste. By doing this they can build a long term relationship where they also provide service instead of just selling the product. It enables them to gain an extra income from the same product and they have more grip on their materials which is from vital importance with the lurking material scarcity, although for much businesses it is more a matter of efficiency and good spare part management.

Becoming servitized is a continuous process. Some businesses already adapted a few things, but businesses cannot become servitized overnight. It is a process of different steps towards the final destination. Tucker (2004) described this already, with the different extends and forms in which organizations could establish servitization. It is not a binary concept, but a continuous process in which different steps will be taken. This got also mentioned by the Praetimus respondent who described his lessons learned with taking different steps and establishing certain circumstances to become servitized in a successful way.

Organizations are also unconsciously able, when they are forced to think about concepts like circularity and servitization they notice that they already do quite some things in this direction that they were not really aware of. When during interviews was asked what organizations already did in this direction they seemed surprised sometimes about the things that were already going well and what kind of services they do already offer. This was also due to the fact that servitization is not widely known yet and thus did some respondents not exactly know what was meant with this term. With regard to the Tucker framework, no organization is fully product-oriented.

Something that businesses should ask themselves is where the value is being created in the chain. Who is earning revenues over their product and where can some progression be made with regard to that. There is the Total Cost of Ownership for users, but whom are these costs going to? Are those complicated transactions made by external parties or is an OEM also able to do this by itself? When a business is more involved with the total value creation of the product, they can translate this into more management over materials, over design and over energy use. This enables them to control more processes and gain more revenue over the total production process. This is also applicable after selling the product. Are there external service companies that provide service on a product or is the OEM also able to provide this service by itself. These are several questions that services should ask themselves in order to see where more profit can be gained through servitization.

In short, important opportunities that have been found are the intensified long term customer relationship that servitization provides. In a matter of time it is also likely that customers start to get used to service-based instead of product-based and the unburdening that the OEM provides and then this relationship will only be improved. The more efficient use of materials including better spare part management could lead to better use of materials and it strengthens circularity. Also new innovations are something that got embraced which could make certain practices easier in the future. Another important opportunity is the extension of life cycles that servitization can lead to. Better servicing can ensure the operationality of a product over the long term, which means lower effort for the OEM, which leads to lower costs, lower depreciation and that could lead to bigger margins. Besides that can the returning of end-of-life materials lead to repairing, refurbishing and remanufacturing which could also help to keep grip on materials and to work more efficient with these materials. With servitization, also upgrades could be provided to keep product not just operational, but also up to date. In the end there will also be legislation that forces businesses to follow the government's ambitions and therefore it is important to think about the impact on their organization. On the long term, not complying with the government's legislation by not becoming circular can be a threat to a business its competitive position. So besides the economic perspective there are also other reasons to move in the direction of circularity.

The barriers that have been found are the cultural changes that servitization implies with a total organization that has to change its way of working. Another thing that has to be sorted out is what kind of service a business wants to provide and if this is actually relevant and possible. Servitization also implies the refurbishment, remanufacturing and the repairing of products and some businesses do not have that kind of facilities which leads to either a financial or a logistic operation. For non-commodity goods it is also difficult to agree on what kind of service they will offer. Does the customer have the same expectations as the OEM and is the OEM able to offer this output through a service contract?

A lot depends on the type of product and the size of the organization. Chainable and Hapert offer everyday products and this production can be standardized and scaled and with the modular design of the product a service agreement can easily be arranged. Other more customized products such as Vencomatic and ASML provide are less easy to standardize and the products have a more complicated design that makes service not much easier. Also financially there is a difference. Income will be gained over a longer period instead of everything at once and with the added service the total income might be higher than before. This could be beneficial, but on the other hand does the product and thus the risk stay on the balance of the OEM and this could be harmful when something happens. When organizations still have an interesting proposition this could be a moment to step in for the BOM to help these organizations in the early phase with an investment for the long term. Another reason could be the change of culture that is required. As mentioned Chainable is a young

start up and they did not have to change a deep-rooted culture within an organization and thus they could immediately start developing their new circular business model. Older organizations with a deep-rooted internal culture will most likely face more resistance when such a transformation appears.

Recommendation for the BOM

What the BOM could do is convince the partners from the urgency of becoming circular. From this research, but also from other researches, lots of reasons to become circular have been established. When companies mention that they are not ready yet for a transformation, the BOM should try to convince them to start as this is the time to gain a competitive advantage instead of following when everyone has already started. If needed, the BOM could also help to get them started with a financial boost when it is about a promising company.

For the BOM there is an interesting role in this situation. For the BOM it is interesting to develop such business models and the opportunities and barriers that appeared from this research can help to have a more focused approach. Firstly, it was interesting to see to which extent the respondents were familiar with the concept servitization. Some of them were not really familiar with it and so they were not familiar with the advantages that it could offer. For the BOM this is something to address within their network to make organizations familiar with this topic and its implications so they can assess whether it could be beneficial for them or not. Especially at the smaller organizations who do not have innovation managers, or Research & Development departments this could be interesting to address.

The BOM does already offer a lot of sessions where businesses with questions on this topic can participate and maybe they could try to diversify this depending on the product or the size of the organizations. By doing this there is an increased opportunity that businesses with similar issues will meet each other and they can learn from each other's experiences and practices. Additional to this the BOM could also set up a forum where organizations can submit their questions or issues, which can be solved by other people from the network. The BOM could also use professionals from the field who provide an example with their practices in the area of efficient spare part management, servitization or circularity and who already went through this transition with the associated cultural change.

The BOM could support businesses by investing in an early phase. Switching to servitization or circularity demands investments in for example a remanufacturing department or service provider through the country. This might form a burden in the beginning, especially for smaller businesses and the BOM could help by investing in this kind of projects, with a good underlying plan, until the market can carry it by itself and it starts being profitable to the specific business.

With regard to the OEM-supplier relationship, which is a problem that the BOM discovered, the BOM should try and seek for the small easier replaceable suppliers as they tend to be the most vulnerable to big OEM's, due to their less distinctive product. With these vulnerable suppliers they OEM can be contacted to see if there can be made some supply chain wide agreement where the whole chain will be activated and involved in the supply chain with a fixed way of working and delivering as a result. This will release the supplier from worriers regarding to their vulnerable position and the OEM can be more specific in their demands towards supplier and even ask more specific services.

In this research there were two actual suppliers, being ATAG, which is a well-known provider of kitchen equipment, and Van Egmond, which is a wholesaler. Van Egmond stays competitive by adding all kinds of services to their products, otherwise they fear to be replaced. A long term

relationship could benefit both the supplier and the OEM related to this topic. With servitization proper spare part management is required and service should be on a high level. When an OEM delivers a product on a service base it is also obliged to provide spare parts of products that break down. These products come often from suppliers, which could vary from wholesalers to high tech manufacturers. For an OEM it is of high importance to know where each spare part is coming from and when they have a thorough knowledge of this they can quickly provide service on the specific machine. When an OEM involves its suppliers in this, they can map where each spare part is coming from and when a part is needed an OEM knows it can rely on the supplier. This creates a mutual reliability and it gives more security to the smaller supplier who was more vulnerable in the beginning as it is needed now to provide service. With regard to that a lot does depend on the type of organization they are dealing with. Organizations with a commodity product are more suitable for servitization than others. Organizations with a more specific customized product are less suitable. When the supply chain as a whole could be pictured with the knowledge where every spare part is coming from a servitization model could be set-up that would also benefit this kind of organizations. This is a construction that could benefit both the OEM as the small supplier.

Recommendations and future research

Based on this research a few recommendations can be made. As mentioned before the existing literature is superficial and unorganized and this does not encourage practical implementation of these circular principles. The existing theory should be more categorized and precise so it encourages the circular economy in practice. A lot of good ideas are already there, but the challenge now is to translate this into an accessible roadmap for manufacturers and other people in the field.

Generally speaking this research focused on specific circumstances within organizations and for future research, researches like this could be scaled up to learn more about specific circumstances at companies instead of the general view. This could lead to more tailor-made results where each of the businesses could benefit from. This research showed that there is no one-size-fits-all approach and thus should specific circumstances always be taken into consideration.

Unfortunately that was no time for in this research, but it could be interesting to do similar researches to see about the OEM-supplier relationship and their attitudes towards servitization and circularity in other chains, maybe even in other sectors. With broader research with more response also a more diverse set of data can be gathered and this might lead to new findings.

Regarding servitization there are also areas where improvement is possible, to start with the visibility of the topic. From this research can be concluded that servitization offers several opportunities, but it turned out that most respondents were not really familiar with the topic. More research should extend the existing body of knowledge on servitization, but it could also help to increase the awareness for a promising concept like this.

Another recommendation for future research would be to dive into the characteristics of businesses that fit the servitization model. From this research a few of these characteristics have been identified, but it could be interesting to see if there are more factors that not have been included in this research.

Reflection and limitations

The aim of this research was to identify barriers and opportunities for businesses in the manufacturing industry regarding the implementation of a servitization business model. This has been researched by interviewing stakeholders from the field with in addition a few experts who could provide more of an overview based on their knowledge and experience. This research contains

a lot of in-depth interviews and additional to the initial literature review and the theoretical framework this research is well-grounded. In the literature review a theoretical framework is proposed and through this framework the interview data has been assessed to provide a structured results section. From this the conclusion and thus the answer on the research question has been proposed. By this the theory on servitization has been combined with the experiences in practice by respondents.

The recording and notation of the interviews has happened in a transparent and careful way with respect for the respondents. Only one of the interviews found place on location, the rest was online so the quality was quite similar and the length of the interviews was quite similar as well. The transcriptions and analyses from each of the interviews went by the same procedure. Unfortunately, one audio record went wrong, so the only source was a summary with mutual consent, but despite the limited data it still was a relevant interview for this research.

In the initial planning the aim was to speak with both an OEM and a supplier from the same chain. The OEM was arranged from the BOM network and during the interview the researcher had to ask for a supplier to conduct a similar interview with. Unfortunately one respondent was not able to provide a supplier while the other preferred another respondent from inside their organization who could tell more about the supplier-OEM relationship. This was unplanned, but based on the already conducted interviews it did not form a barrier to come to a conclusion, but more input could have helped to create a broader and thus more reliable set of data.

A multiple case study enables to dive into these specific circumstances and this is why has been chosen for this approach. With four cases there was both space to go in depth as enough data to compare and generalize and this help to create a view as broad as possible.

6. References

- ASML. (n.d.). *What is Moore's Law?* Retrieved 21 August 2021, from <https://www.asml.com/en/technology/all-about-microchips/moores-law>
- Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The servitization of manufacturing. *Journal of Manufacturing Technology Management*, 20(5), 547–567. <https://doi.org/10.1108/17410380910960984>
- Bastein, A. G. T. M., & Willems, M. P. J. (2019). Slim èn circulair : hoe de smart industry circulaire economie in de praktijk brengt : een verkenning onder Brabantse bedrijven. TNO. <http://resolver.tudelft.nl/uuid:e0e90b50-5bac-4e58-affa-4af6d493aea2>
- Benedettini, O., Neely, A., & Swink, M. (2015). Why do servitized firms fail? A risk-based explanation. *International Journal of Operations & Production Management*, 35(6), 946–979. <https://doi.org/10.1108/ijopm-02-2014-0052>
- BOM. (n.d.). *Samen met ondernemers bouwen aan een toekomstbestendige Brabantse economie* | De Brabantse Ontwikkelings Maatschappij. Retrieved 22 February 2021, from <https://www.bom.nl/over-bom>
- CTAC. (n.d.). *Servitization in Manufacturing & de Maakindustrie | As-a-Service*. Retrieved 5 March 2021, from <https://ctac.nl/branches/manufacturing/servitization#:~:text=Productiebedrijven%20die%20niet%20langer%20producten,cashflow%20wordt%20stabiel%20en%20voorspelbaar.>
- De Meeuw. (2021, July 20). *De Meeuw bouwt flexibel, of het nu een tijdelijk of permanent gebouw betreft*. <https://www.demeeuw.com/>
- Dutch Planning Agency for the Living Environment (PBL). (2016, March). *Waarom een circulaire economie?* <https://themasites.pbl.nl/o/circulaire-economie/#>
- Ellen Mac Arthur Foundation. (2013). *Figure 1: The economy by the Ellen Mac Arthur Foundation* [Figure]. <https://ellenmacarthurfoundation.org/videos/basics-of-a-circular-economy>
- Elzinga, R., Reike, D., Negro, S. O., & Boon, W. P. C. (2020). Consumer acceptance of circular business models. *Journal of Cleaner Production*, 254, 119988. <https://doi.org/10.1016/j.jclepro.2020.119988>
- European commission. (2019, December). *The European Green Deal*. <https://eur-lex.europa.eu/legal-content/NL/ALL/?uri=CELEX:52019DC0640>
- Hao, Z., Liu, C., & Goh, M. (2021). Determining the effects of lean production and servitization of manufacturing on sustainable performance. *Sustainable Production and Consumption*, 25, 374–389. <https://doi.org/10.1016/j.spc.2020.11.018>
- Innovatie Zuid. (2012). *Service Logistiek in Zuid Nederland*. <https://www.regionbedrijf.nl/nieuws/nieuw-roadmap-service-logistiek.4018/>
- Jones, T. C., & Riley, D. W. (1985). Using Inventory for Competitive Advantage through Supply Chain Management. *International Journal of Physical Distribution & Materials Management*, 15(5), 16–26. <https://doi.org/10.1108/eb014615>

- Kastalli, I. V., & Van Looy, B. (2013). Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. *Journal of Operations Management*, 31(4), 169–180. <https://doi.org/10.1016/j.jom.2013.02.001>
- Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics*, 143, 37–46. <https://doi.org/10.1016/j.ecolecon.2017.06.041>
- Kryvinska, N., Kaczor, S., Strauss, C., & Gregus, M. (2014). Servitization Strategies and Product-Service-Systems. *2014 IEEE World Congress on Services*. Published. <https://doi.org/10.1109/services.2014.52>
- Martinez, V., Bastl, M., Kingston, J., & Evans, S. (2010). Challenges in transforming manufacturing organisations into product-service providers. *Journal of Manufacturing Technology Management*, 21(4), 449–469. <https://doi.org/10.1108/17410381011046571>
- Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2011). DEFINING SUPPLY CHAIN MANAGEMENT. *Journal of Business Logistics*, 22(2), 1–25. <https://doi.org/10.1002/j.2158-1592.2001.tb00001.x>
- Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2011, May 10). *Figure 2: Types of supply chains* [Figure]. <https://doi.org/10.1002/j.2158-1592.2001.tb00001.x>
- Ministerie van Buitenlandse Zaken. (2021, August 10). *All about OECD Guidelines; general information*. OECD Guidelines | National Contact Point OECD Guidelines. <https://www.oecdguidelines.nl/oecd-guidelines/all-about-the-oecd-general-information>
- Ministerie van Infrastructuur en Waterstaat. (2020, September 21). *Nederland circulair in 2050*. Circulaire economie | Rijksoverheid.nl. <https://www.rijksoverheid.nl/onderwerpen/circulaire-economie/nederland-circulair-in-2050>
- Mishra, A. A., & Shah, R. (2009). In union lies strength: Collaborative competence in new product development and its performance effects. *Journal of Operations Management*, 27(4), 324–338. <https://doi.org/10.1016/j.jom.2008.10.001>
- Netherlands Enterprise Agency, RVO. (2021, January 13). *Corporate social responsibility (CSR)*. Business.Gov.Nl. <https://business.gov.nl/regulation/corporate-social-responsibility/>
- PA Consultancy Group. (2017, August 7). *Maakbedrijven die servitization negeren zullen marktaandeel verliezen*. Consultancy.Nl. <https://www.consultancy.nl/nieuws/14443/maakbedrijven-die-servitization-negeren-zullen-marktaandeel-verliezen>
- RTL. (2019, February 15). *Automobilisten kiezen vaker voor privé-leaseauto: 150.000 op de weg*. RTL Nieuws. <https://www.rtlnieuws.nl/economie/life/artikel/4610961/automobilisten-kiezen-vaker-voor-privé-leaseauto>
- Service-based vs product-based*. (2012, March). [Table 1]. Verschillen tussen service- en productbusiness. <https://adoc.pub/queue/maakindustrie-ontwikkelpaden-voor-servicebusiness.html#>
- Tucker, A. (2004, July 13). *Product-service systems* [Figure]. Eight Types of Product–Service System: Eight Ways to Sustainability? Experiences from SusProNet. <https://doi.org/10.1002/bse.414>

Tukker, A. (2004). Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. *Business Strategy and the Environment*, 13(4), 246–260.

<https://doi.org/10.1002/bse.414>

U.S. Environmental Protection Agency Office of Solid Waste, White, A., Stoughton, M., & Feng, L. (1999, mei). *Servicizing: The Quiet Transition to Extended Product Responsibility*.

<https://tellus.org/pub/Servicizing%20-%20The%20Quiet%20Transition%20to%20Extended%20Product%20Responsibility.pdf>

van der Putten, J. (2018, February). *Servitization*. MT Media Group.

<https://www.nibc.com/media/1833/nibc-whitepaper-servitization-nl.pdf>

Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services.

European Management Journal, 6(4), 314–324. [https://doi.org/10.1016/0263-2373\(88\)90033-3](https://doi.org/10.1016/0263-2373(88)90033-3)

Vermeulen, W. J. V., Reike, D., & Witjes, S. (2019). Circular Economy 3.0; Solving confusion around new conceptions of circularity by synthesising and re-organising the 3R's concept into a 10R hierarchy. *Circular Economy 3.0; Solving Confusion around New Conceptions of Circularity by Synthesising and Re-Organising the 3R's Concept into a 10R Hierarchy*, 1–4.

<https://repository.ubn.ru.nl/handle/2066/230427>

White, A. L., Stoughton, M., & Feng, L. (1999). *Servicizing: The Quiet Transition to Extended Product Responsibility*. Published.

https://skat.ihmc.us/rid=1218909562171_788101477_13296/servicizing%20Tellus%20EPeR%20case%20study%20Electrolux.pdf

Yin, R. K. (2009). *Case Study Research* (4de ed.). SAGE Publications.