

The configurations of inhibiting and stimulating factors in servitization

The cases within the construction industry

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Management summary

Purpose- It appears that practice and literature do not know how the transformation from a product-oriented business model to a service-oriented business model can be made and that it is still unclear which factors influence servitization positively or negatively. This research will explore the configurations of inhibiting and stimulating factors in servitization in the construction industry. Besides, the configurations will be identified, and therefore providing a more detailed insight into the common causes between the different cases in this study.

Methodology- Semi-structured interviews were used to collect the data. Because of the corona situation, these interviews were not conducted face to face, but through image calling. At the end of each condition to be measured, a conclusion question was asked, which the respondent answered with a yes or no answer. This answer could then be calibrated to a 0 or a 1, making the data suitable for analysis through qualitative comparison analysis (QCA) and necessary comparison analysis (NCA). These analysis methods gave a more in-depth insight into the sufficient and necessary conditions for a service-oriented business model. The next step was to return to the transcripts and encode them to have a deeper understanding of the sufficient and necessary conditions.

Results- The analysis of the QCA demonstrates that there are almost two identical configurations towards a service-oriented business model. The common conditions between the two configurations demonstrate that the companies offering the product as a service: [I] have no problems with pre-financing; [II] do not experience resistance in the supply chain; [III] have their own control over design, installation, and maintenance; [IV] have ICT systems that generate data to provide insight into the behavior of the concept.

Besides the fact that these four conditions are present in both configurations from the QCA, the NCA also demonstrated that the above four conditions are necessary. By reading and encoding the transcripts, a possible synergy between these four conditions were discovered. Namely, the service-oriented companies have applied a particular form of vertical integration as a result of which there are relatively fewer partners involved in the concept and, therefore, fewer conflicts of interest, which subsequently leads to less resistance in the chain. While pre-financing may at times be a challenge even for service-oriented companies, they use data to substantiate that the concept is interesting and to convince debt capital providers that there are fewer risks than they assume. Therefore, as long as the service-oriented model is substantiated by data, one can achieve a turnaround among debt providers and attract more partners willing to finance the concept.

A remarkable difference between the two configurations was the condition of customer acceptance. It appeared that this condition was absent within configuration [II]. This configuration was created through infrastructure-oriented companies. These companies mainly have the government as their customer. The transcripts reveal that the government is very reluctant in this kind of concept, but

that the government does try to move towards service concepts. A distinction could still be made between provincial and local governments. Provincial governments seem to stand more for the concept, but the general picture is cautious. The last difference was the regulations regarding ownership. Most companies experience almost no hinder with regard to the "ownership" regulations. Creative solutions have been developed, such as surface right, a right of way, or in exceptional situations use of the rental constructions. These creative solutions are not always applicable.

Theoretical implications- Contrary to mentioning barriers, the literature give little attention to the development of tools to solve these barriers (Baines, Rajkumar, Lightfoot, Benedettini, & Kay, 2009), and according to Mont (2002), the literature should also give more attention to the design side of product-service-systems. This research has contributed to the possible ingredients in the tools to be developed. As described above in the results, the use of data and the application of vertical integration can be important ingredients. Vermund et al. (2019), also asked for more empirical data to generalize his mentioned barriers. This study illustrates that the barriers; there is no market acceptance; there is resistance in the chain, and barriers relating to pre-financing also apply in the construction industry. In other words, the literature demands more attention to the development of tools to solve the barriers. This research identifies the use of data and vertical integration as possible ingredients in these tools. Action research will be able to investigate these ingredients further in a search for the tools and more empirical data has been added to generalize certain barriers.

Practical implications- This research has its added value depending on the degree of knowledge of the servitization of the managers and directors. For the group that argues that ownership is an obstacle, several possible solutions are suggested that can give them new insights. For the group that doubts whether the customer is open to the concept, the suggestion is made to think about how their customer earns his money. In the construction industry, the suggestion is made to consider more project developers with their own portfolio and investors for this type of concept, as opposed to governments and contractors.

For the group that encounters resistance in the chain, an option is provided to apply a certain degree of vertical integration. No answer has yet been given to the question of the extent to which there should be vertical integration. However, it has to be kept in mind that vertical integration is only a tool and not an end in itself. Resistance in the chain is caused by the many affiliated partners with conflicting interests. Vertical integration is a way to reduce the number of affiliated partners, but there is also an opportunity to reduce the conflicting interests between the many partners. Unfortunately, the degree of vertical integration falls out of scope of this study.

To conclude, it appears that data have an essential role in providing the debt capital for the realization of the service-oriented concept. Other studies have already assumed that data can be used for further discovery and to make the product more efficient. This research adds that the data can also be used as an argument to convince customers and debt capital providers of the concept. In other words, the correct use of data can play an essential role in the realization of service concepts.

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List of abbreviations

Abbreviation	
BM	Business model
BMI	Business model innovation
NCA	Necessary comparison analysis
PaaS	Product as a service
PSS	Product service systems
QCA	Qualitative comparison analysis

Glossary

Word	Definition	Reference
Business model	<i>“A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore, we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences”</i>	Osterwalder et al., 2005, p. 3
Business model innovation	"Business model innovation is a process of transformation from one business model to another within the established companies or after mergers and acquisitions".	Geissdoerfer, et al., 2016, p. 406
Circular economy	<i>“a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops”</i>	Geissdoerfer et al., 2017, p. 9
Configuration	<i>“Specific combination of factors (ingredients, variables, determinants) that produces a given outcome”</i>	Ragin & Rihoux, 2009, p. XVII
Product as a service	Shift from the tangible product-oriented to the non-tangible service-oriented	Ducq et al., 2012
Product service system	A bundle of products and services that collectively meet a customer's need	Mont, 2002
Qualitative comparison analysis	<i>“systematic comparison of cases, with the help of formal tools and with a specific conception of cases”</i>	Ragin & Rihoux, 2009, p. 6
Servitization	<i>“the movement to bundles of customer-focused combinations of goods, services, support, self-service, and knowledge”</i>	Vandermerwe & Rada, 1988, p. 1

1. Introduction

1.1 Background Research

The twentieth century, with its organizations with a dominant form of bureaucracy, has led to effective and efficient production that has increased prosperity in the West (McAuley, Duberley, & Johnson, 2007). However, the desire to produce as much as possible has led to a clash of humanity with the natural system of the earth (Hart, 2010). The linear model in which we produce the products and dispose of them after their life cycle is a matter of social debate. There are increasing demands for a circular economy based on the principle "made to be made again" (Ellen-MacArthur-Foundation, 2020). Such an economy requires a different way of producing and business management (De los Rios & Charnley, 2017). Since current business models focus on the linear economy, circular business models are needed to stimulate the circular economy (Lewandowski, 2016).

The literature on circular business models focuses mainly on the system of "product as a service" (Rosa, Sassanelli, & Terzi, 2019). Because, it is argued that offering the product as a service can lead to a more circular business model (Jonker, Kothman, Faber, & Montenegro Navarro, 2018), which in turn results in a reduced environmental impact (Neely, 2009). Since ownership is taken away from consumers, the product returns to the manufacturer, who may consider dematerialization at an earlier stage (Jonker et al., 2018). However, this requires a transformation from product-oriented- to service-oriented business models. This transformation is also referred to as servitization (Baines, Ziaee Bigdeli, Sousa, & Schroeder, 2019). In other words, servitization is perhaps the way to a more circular model that can reduce the impact on the environment.

In addition to the social benefit, namely the reduction of the environmental impact, servitization also offers an individual benefit for the manufacturers. Servitization can lead to closer relationships between the manufacturer and the customer, which ultimately enables the manufacturer to distinguish itself more from the competitors (Vandermerwe & Rada, 1988). The manufacturer is also more likely to identify more suitable solutions for the customer, which increases the customer's performance (Baines & Lightfoot, 2013). According to Porter, et al. (1989), an organization is of added value if the customer's performance is increased or costs are reduced. Due to low production costs, production has increasingly shifted from the West to underdeveloped economies (Baines & Lightfoot, 2013), making it difficult to compete on the cost price. It is, therefore, more critical for the manufacturer to focus on increasing performance. In conclusion, servitization reduces the impact on the environment and gives the manufacturer a competitive advantage.

1.2 Problem definition

Several problems arise in servitization. To understand these problems better, it was attempted to position the problems from two layers (Van de Ven, 2007). The first layer concentrates on those as

managers who are directly affected by the problem. The second layer approaches the problem from a broader perspective, such as industry.

Regarding the first layer, managers lack a certain amount of know-how to transition to a service-oriented business models (Vermunt, Negro, Verweij, Kuppens, & Hekkert, 2019; Guldmann & Huulgaard, 2020). This causes uncertainty regarding the applicability and feasibility of these type of models (Mont, 2002). Thus, even though servitization can lead to a more circular business concept and a competitive advantage, managers and directors may lack the knowledge on how to implement them.

Concerning the construction industry, increasing attention is being paid to the long-term status of a building. The construction industry is moving cautiously towards the integration of maintenance and operations during the installation of a building (Galera-Zarco, Morales-Gallego, & Pérez-Aróstegui, 2014). However, this move carries with it a higher degree of dependency on external partners, and this is where many obstacles arise (Vermunt, Negro, Verweij, Kuppens, & Hekkert, 2019). For example, all individual partners are likely to behave as separate profit centers in this industry (Leiringer, Green, & Raja, 2009). In other words, the construction industry wants to servitize, but they need theory that creates more clarity.

In addition to the literature review, the problem was examined from a practical point of view (Van de Ven, 2007). Prior to this study, two discussions were held with directors of construction organizations who are transforming their businesses into service-oriented business models. They described several problems they encountered. For example, one director mentioned that when their product was assembled to a building, the ownership of that product was transferred to the building's owner following the law. The literature such as Vermunt, et al. (2019), also mentions legal barriers. However, there are also examples of manufacturers who do have their products assembled to a customer's building in a service-oriented business model (Mitsubishi, 2020). In other words, other cases within the same industry are not hindered by regulation.

When a diagnosis of the problem is drawn up, and the nature of the problem becomes evident in the context (Van de Ven, 2007), it appears that it is not clear either from practice or from the literature how the transformation from the product-oriented business model to the service-oriented business model proceeds and which factors positively or negatively affect the transformation. Hence, a more in-depth analysis of the barriers and stimulating factors in this transformation process is needed.

1.3 Research outline

1.3.1 Research goal

This research explores the configurations of inhibiting and stimulating factors in servitization. Contrary to just exploring the inhibiting and stimulating factors, the reason for identifying the configurations is that it provides a more detailed understanding of the common causes between the cases, and key ingredients can also be identified (Ragin & Rihoux, 2009). There will also be insight into sufficient and necessary variables that lead to a service-oriented business model. Since servitization may be industry dependent (Baines & Lightfoot, 2013), this research specifically focuses on the construction industry. According to an industry insider, the construction industry is very complex (due to its many stakeholders), which makes it interesting for research.

At the end of the thesis, a model of different factors is presented to provide more clarity into which ones positively or negatively influence the transformation process. This model is based on a variance model in which, in contrast to the process model, it involves taking identification of the antecedents that influence the phenomenon. The model serves as the basis for hypotheses for follow-up research and will thus ultimately function as a mediator between practice and theory (Van de Ven, 2007). This gives the model both practical and theoretical relevance.

1.3.2 Research question

“What are the configurations of inhibiting and stimulating factors for construction manufactures in their transformation from a product-oriented to a service-oriented business model in the Netherlands?”

1.4 Relevance

1.4.1 Practical relevance

From a practical perspective, organizations that are in the process of transforming from a product-oriented to a service-oriented business model will be able to use this research to see which factors inhibit and which accelerate the transformation. They can respond by investing in the right factors. This is also a step towards answering the fundamental question of how companies can transform a product-oriented business model to a service-oriented one.

1.4.2 Theoretical relevance

The question of how companies can transfer to a service-oriented model is particularly interesting from a theoretical perspective, and has been addressed by Baines, Rajkumar, Lightfoot, Benedettini, & Kay, (2009). They write that attention is paid to the barriers that occur doing the process of servitization, but that few instruments are being developed to solve these barriers. It will become clearer which ingredients need to be included in the tools to solve the barriers by examining the

configurations of inhibiting and stimulating factors. Because, a solution for an inhibiting factor may be created through a stimulating factor. The ingredients also create more clarity on the design side of product-service systems, and therefore this research will also meet the demand of Mont (2002). Besides, because this research focuses entirely on the construction sector, it will provide insight into the extent to which the general barriers apply to an underexposed sector, such as construction. In the end, follow-up research is needed to test the results from this study, and future action research can use the results of this study to develop the tools to achieve effective servitization of construction companies as well as other industries.

2. Conceptual background

In order to get more clarity on the concepts related to the topic "the transformation from product-oriented to service-oriented business models", a literature study was conducted before the research. A literature study provides insight into the concepts and theories used concerning a specific subject (Bell, Bryman, & Harley, 2018). The study also provides insight into relevant keywords that link this study to specific disciplines (Boeije, 2009), in this case "business models" and "business model innovation." Common concepts are servitization, product as a service, and product-service systems. More details on the disciplines and concepts is provided in the following sections.

2.1 Business models

A business model (BM) is considered the blueprint for an organization's way of operating (Magretta, 2002). This blueprint illustrates the added value the organization can offer its customers and how it has organized this. A strong BM is essential because it provides a substantial competitive advantage. Unlike a product, a BM is more difficult to be copied by a competitor (Teece, 2010). The literature identifies four essential elements of a BM: the architecture of the value proposition, the architecture of internal and external value creation, and finally, the financial architecture (Futterer, Schmidt, & Heidenreich, 2018). In other words, a BM describes how an organization operates, taking into account internal and external value creation and its financial underpinning.

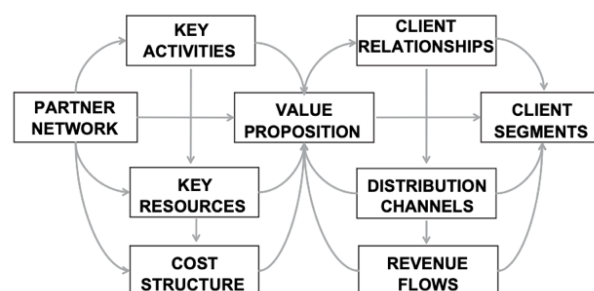


Figure 1. Osterwalder's 9 point decomposition of a Business Model. Reprinted from *Business Model Innovation: Opportunities and Barriers*, by C. Chesbrough, 2010

A well-known framework for describing a BM is the Business Model Canvas (Osterwalder & Pigneur, 2009), illustrated in figure 1. It describes a BM in nine building blocks; customer segments, customer relationships, channels, value proposition, core activities, core resources, core partners, cost, and revenue streams. The four core elements mentioned above are included in these nine building blocks.

In the literature, BMs are described by applying the static approach or the transformative approach. The static approach emphasizes which components belong to a BM and the aim is to create a common language to facilitate discussion of BM, but there is also a transformative approach. In the transformative approach, the emphasis is on a BM as an instrument for innovation (Demil & Lecocq, 2010). While enough has been written about business model innovation, there is unfortunately still a lack of clarity in the literature about when innovation is involved. According to La Rocca & Snehota (2014), for example, innovation refers to the implementation of new ideas within an organization. However, it is not clear whether an idea is considered new if it is new within the company, within the sector, or within society (Schiavone, Paolone, & Mancini, 2019). The next section elaborates on business model innovation.

2.2 Business model innovation

Despite lack of clarity as to what can be termed innovation, there are some clear patterns, especially when it comes the so-called disruptive innovation. According to Markides (2006), a pattern is visible in disruptive innovation, which is actually a redefinition of what a product or service is and how it is provided to the customer. The right business model innovations can change industries and lead to spectacular profits (Johnson, Christensen, & Kagermann, 2008). A perfect example of this is Apple with its iPod in combination with iTunes. In other words, business model innovation can be created by redefining the value proposition and how it is delivered to the customer and a successful innovation can then lead to a change of the entire industry.

Because of many changes in society, BMs are changing too. Business model innovation covers different areas such as sustainability, circular economy, digitization, and servitization (Pieroni, McAloone, & Pigosso, 2019). Servitization relates to innovation from product-oriented to service-oriented BMs leading to long-term performance (Visnjic, Wiengarten, & Neely, 2016). In other words, the change from product oriented to service oriented is a kind of business model innovation and is also called servitization. More information can be read in the following sections.

2.3 Product as a service

Product as a service (PaaS) refers to the shift from the tangible product-oriented to the non-tangible service-oriented BM (Ducq, Chen, & Alix, 2012). In the literature, this shift is described under the terms product service systems (PSS) and servitization. The next two paragraphs will provide more clarity on these two concepts.

2.3.1 Servitization

Servitization concerns the transition from a product-oriented- to a service-oriented BM (Baines et al., 2019). This transition refers not to an individual product but to the change of the entire BM (Brax & Visintin, 2017). The service orientation is not about adding a simple service element, but about advanced service elements (Baines et al., 2019). According to the introducer of servitization, advanced service elements concern the combinations of goods, services, support, self-service, and knowledge (Vandermerwe & Rada, 1988). They conceptualize servitization as "*the movement towards bundling of customer-oriented combinations of goods, services, support, self-service and knowledge*" (Vandermerwe & Rada, 1988, p. 1). In other words, servitization is about the transformation from a product-oriented- to a service-oriented BM in which a combination of advanced services are offered to the customer.

To illustrate for the meaning of the five service elements, the figure 2 below has been added from Vandermerwe & Rada (1988).

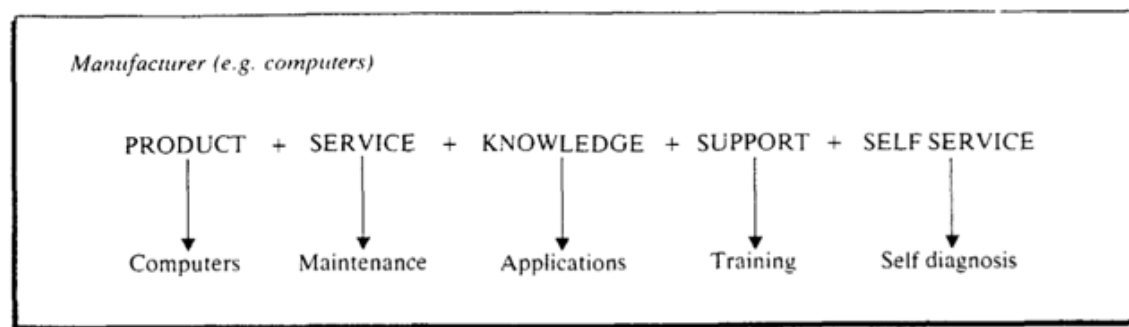


Figure 2. Manufacturer (e.g. computers). Reprinted from "Servitization of business: Adding value by adding services," S. Vandermerwe, 1988

With the product, one can only think of delivering the tangible product. The service element adds maintenance. The knowledge is about knowing why and how the customer wants the product to lead to a superior problem solution. Support is about training to run the maintenance service and the self service is about the customer being fully satisfied and no longer having to worry about the product (Vandermerwe & Rada, 1988). Note that the definition of the advanced services refers to the combination of the service elements, which are not to be seen as phases. Also, the advanced services are often combined with long contracts (5-15 years) as the manufacturer takes more responsibility to strive for higher quality (Baines & Lightfoot, 2013). In other words, servitization focuses on the transition from a product-oriented to an advanced service-oriented BM. Where, the advanced services involve a combination of delivering the tangible product, maintaining this product, training and self-diagnosing. These combinations are often agreed in long-term contracts.

In the literature, there are three approaches to the concept of servitization: the end state models, gradual transition models, and stepwise progression models. The end-state models concentrate on the

end result of servitization, gradual transition models concentrate on the process of servitization, and the stepwise progression models concentrate on identifying possible new phases that improve servitization (Brax & Visintin, 2017). This study will be in line with the literature on gradual transition models. Namely, this study will provide insights into which constructs influence the transformation.

2.3.2 Product service systems

Compared to the advanced services, product-service systems (PSS) go a step further. (Mont, 2002), defines PSS as a bundle of products and services that together meet a customer's need. Whereas servitization only concentrates on the transition to advanced services, PSS concentrates on the total system associated with the advanced services (Baines & Lightfoot, 2013). PSS includes finance as an advanced service. However, while the customer does not own the product, the product does not necessarily have to be owned by the manufacturer either, but can be owned by a financial partner (Baines & Lightfoot, 2013). The manufacturer has to switch from the product mindset to the system mindset, thus extending the manufacturer's responsibility to matters that normally fall outside the buyer-seller relationship. Besides the advanced services, these also include the return of materials (Baines et al., 2007). In other words, product-service systems go step further than the advanced services. These include the financial component and the take-back of materials to the system.

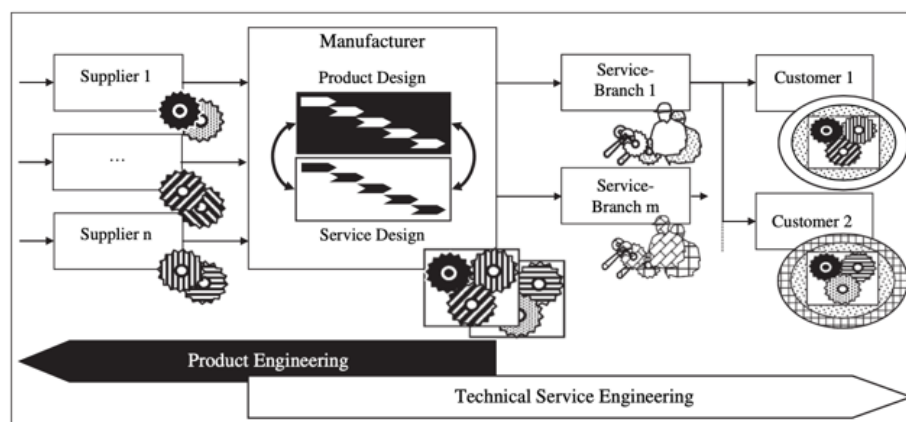


Figure 3. Scenario for integrated PSS engineering in the investment goods industry. Reprinted from "Life cycle-oriented design of technical Product-Service Systems," by J. Aurich, 2006

Figure 3 provides an interesting representation of where a PSS can be made of. This figure is taken from Aurich et al. (2006), who explain that the manufacturer works closely with the service branches. Unfortunately, the paper does not explain what kind of partners the service branches consist of. It can be suggested that one of the partners is the financial partner. Figure 3 clearly illustrates that "product engineering" and "technical service engineering" have a certain degree of overlap, which indicates the close cooperation between the manufacturer and the service branches. In other words, the manufacturer and the service branches together form a system to offer solutions to the customer that would fall outside the buyer-seller relationship in a traditional model.

However, the solutions can take different forms. According to Baines et al. (2007), a distinction can be made between product-oriented PSS, user-oriented PSS, and results-oriented PSS. Product-oriented PSS focuses mainly on traditional sales, but with additional services included in the purchase agreement, such as maintenance and design that takes into account the product lifespan and encourages re-use. In user-oriented PSS, the customer no longer owns the product, and the manufacturer has an incentive to maximize its lifespan. In results-oriented PSS, the manufacturer thinks mainly in terms of problem-solving: Baines et al. (2007) use the example of the washing machine manufacturer that rents washed clothes. In other words, different approaches are conceivable within the PSS.

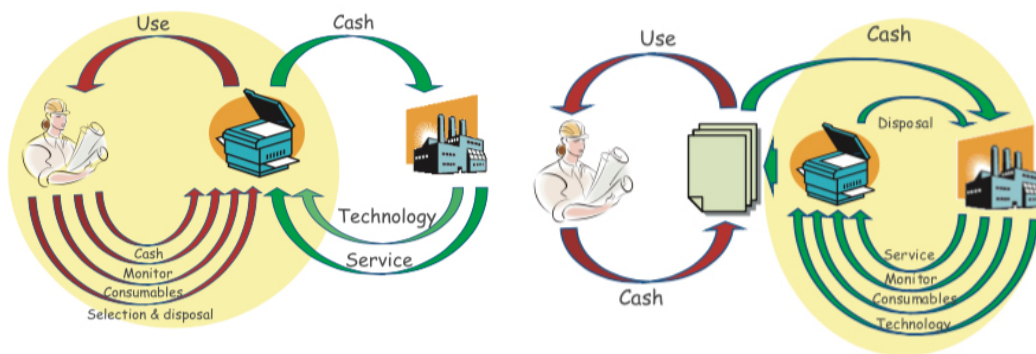


Figure 4. Traditional purchase of photocopier and purchase of a document management capability. Reprinted from *Proceedings of the Institution of Mechanical Engineers*, by T. Baines, 2007

Figure 4 illustrates user-oriented PSS. Linking this figure to Figure 3, it can be said that the picture of the manufacturer in Figure 4 concerns the manufacturer or the service branches. This does not necessarily mean that the manufacturer is the owner of the product – the owner could also be the service branches (Baines & Lightfoot, 2013). Nevertheless, Figure 4 clearly illustrates that the customer pays for the output of the product instead of buying the product (Tukker, 2004). In conclusion, PSS are an extension of the advanced services, and a distinction can be made between product-oriented PSS, user-oriented PSS, and result-oriented PSS. The next section addresses PSS specific to the construction industry.

2.4 Contracts construction industry

In order to project the theory of PSS more accurately onto the construction industry, it is necessary to consider the basic forms of contracts that are present within this industry. One of these contract forms is the traditional construction method. In this method, the design and construction are separated from each other, and there is a clear division of responsibilities within the construction chain. This construction method is the first step in the servitization process, as described by Vandermerwe and Rada (1988), in which the manufacturer focuses only on the product. In other words, construction

manufacturers who build only according to the traditional construction method can be categorized as product-oriented.

A variant on the traditional method is the design and build (DB) contract form, where the contractor is responsible for both design and construction. The justification for this form of contract is that the efficiency of the construction process is already considered during the design phase. Similar terms are design-construct (DC) and engineering-construct (EC)¹. In addition to the DB contract, there is also the design-build-maintain (DBM) contract, where the order to design, build, and maintain is given to the contractor². Referring to Vandermerwe and Rada's article (1988), this is step two in which service (maintenance) is added to the product. In other words, construction manufacturers who build with DB(M) contracts are already engaged in servitization, and it may already be possible to describe this as a product-oriented PSS.

However, the user-oriented PSS only arises with the DBFM contract. This form of contract is characterized by the addition of the financial element (F) and by the fact that the various phases of a project are put out to tender in full. Incidentally, DBFM contracts are used not only by government institutions but also by private companies³. In other words, construction manufacturers who build with DBFM contracts are at an advanced stage of servitization where the user-oriented PSS is already in place.

Finally, there may be an extension of the contract form discussed above with the operate (O) element. The DBFMO contract is characterized by the fact that one purchases a service in addition to a product. An example would be the supply of sluices where the manufacturer also operates the sluice. In this type of contract, the main focus is on the result, and it can thus be linked to the result-oriented PSS. In other words, construction manufacturers who build according to DBFMO contracts are furthest down in the servitization process and can be categorized as result-oriented PSS. Table 1 provides a summary of the usual contract forms within the construction industry and how they link to the steps of servitization.

¹ Rijksoverheid. (2020). Contractvorm DB. Retrieved from <https://www.rijksoverheid.nl/onderwerpen/publiek-private-samenwerking-pps-bij-het-rijk/pps-contractvormen/contractvorm-db>

² Rijksoverheid. (2020). Contractvorm DBM. Retrieved from <https://www.rijksoverheid.nl/onderwerpen/publiek-private-samenwerking-pps-bij-het-rijk/pps-contractvormen/contractvorm-dbm>

³ Rijksoverheid. (2020). Hoe werkt DBFM(O)? Retrieved from <https://www.rijksoverheid.nl/onderwerpen/publiek-private-samenwerking-pps-bij-het-rijk/pps-contractvormen/contractvorm-dbfmo/hoe-werkt-dbfmo>

Table 1 Contract forms within the construction industry

Description contract	Abbreviation	Servitization stage	Reference
Separate phases (traditional method)	TM	Product	Vandermerwe & Rada, 1988
Design & Build	DB	Product + services	Vandermerwe & Rada, 1988
Design, Build & Maintain	DBM	Advanced services	Vandermerwe & Rada, 1988
Design, Build, Finance & Maintain	DBFM	Use-oriented PSS	Baines et al., 2007
Design, Build, Finance, Maintain & Operate	DBFMO	Result-oriented PSS	Baines et al., 2007

3. Literature review

3.1 Review strategy

In this research, a systematic literature review was used. A systematic literature review implies that the literature is approached and documented systematically. This increases the transparency of the research and reduces a possible bias from the researcher (Bell et al., 2018). In the systematic approach, the search was first conducted for the factors inhibiting the servitization process. Afterwards, synonyms such as barriers and obstacles were added to the search. Subsequently, the terms "drivers" and "enablers" were added to search terms. This resulted in a total of 1075 articles. All this is summarized in Table 2. In other words, the first search for the factors that influence the transformation from a product-oriented to a service-oriented BM results in 1075 articles.

Table 2 Search strings

Search engine	Search strings	Results
Scopus	(TITLE-ABS-KEY (servitization)) AND (barriers)	197
	(TITLE-ABS-KEY (servitization)) AND (obstacle)	13
	(TITLE-ABS-KEY (servitization)) AND ("inhibiting factors")	2
	(TITLE-ABS-KEY ("product as a service")) AND (barriers)	5
	(TITLE-ABS-KEY ("product service systems")) AND (obstacle)	34
	(TITLE-ABS-KEY ("product service systems")) AND (barriers)	358
	(TITLE-ABS-KEY ("product service systems")) AND (drivers)	318
	(TITLE-ABS-KEY ("product service systems")) AND (enablers)	148
Total		1075

Table 3 Rating journals

Source	Rating	Results
2019 Australian Business Deans Council (ABDC) Journal Quality List	A*	42
	A	252
	B	59
	C cited >300	1
Total		354

In order to distinguish between more reputable and possibly less reputable articles, the rating of the journal in which the article was published was considered. For this purpose, the ABDC journal list from 2019 was downloaded in Excel, and a vertical search between the 1075 articles and the ABDC list was run to gain insight into the quality of an article. Additionally, a search was done for articles in C

journals that were cited more than 300 times to identify any interesting articles in this journal category. For the number of citations, the year of publication was taken into account. This was done to include relatively new articles in the analysis, which have not yet had the opportunity to be cited frequently. All this resulted in 354 articles.

The 354 articles were then filtered by document type "review." Based on the title of the article, this resulted in 19 relevant review articles for this study. Subsequently, the same was done for document type "article." This last filter resulted in 45 articles. The ATLAS.ti program was used to analyze the relevant articles. This program is often used to encode interview transcripts, but in this research, it has been used to gain a deeper insight into the content of selected articles by assigning codes to relevant parts of the text of the 64 articles. The results of this literature review are presented in the continuation of this chapter.

3.2 The transformation

The process of servitization can be divided into several phases. The first phase concerns the offering of physical products. In the second phase, service is added to the portfolio, and in the final phase, no distinction is made between the two the product and the service (Vandermerwe & Rada, 1988; Aurich et al., 2006). These phases are also referred to as basic, intermediate, and advanced services (Baines & Lightfoot, 2013). However, while the transformation process is often considered to be linear, there are doubts as to what extent it proceeds in a linear manner (Baines et al., 2019). It even seems that the process is rather intuitive as structured (Martinez, Neely, Velu, Leinster-Evans, & Bisessar, 2017). Because the process of servitization is probably not linear, it is difficult to categorize the manufacturers in this study. The confusion is caused by the intermediate services. For example, one can debate whether a construction manufacturer with DBM contracts belongs to the intermediate or the advanced services. There is no clear dividing line and this research mainly focuses on the construction manufacturers with DB and DBFM(O) contracts. The following sections provide an insight into the variables that can influence the shift from basic to advanced services.

3.2.1 Internal barriers in the transformation

The literature describes many barriers that hinder the transformation from a product-oriented to a service-oriented BM. These barriers can be divided into internal and external barriers. This section discusses the internal barriers, while the next chapter discusses the external barriers. The internal barriers can be divided into three categories: financial, organizational, and knowledge and technology related (Vermunt, Negro, Verweij, Kuppens, & Hekkert, 2019). This subdivision has been used because the article by Vermunt et al. (2019) was published relatively recently in a reputable journal: they already made an analysis of the barriers in the literature and drew up the subdivision based on that analysis. In the following paragraphs, the three internal barriers are explained in more detail and Table 4 lists the barriers to be discussed.

Tabel 4 Internal barriers

Internal barriers	Description barriers
Financial	Lack of financial resources
	High up-front investment costs
	Higher costs related to the new CBM
	Unclear financial business case
Organizational	Administrative burden
	Organization of reverse infrastructures
	More complex management and planning process
Knowledge and technology	Lack of know-how and expertise
	Lack of information/ data
	Ability to deliver high quality products
	Design challenges to create durable products

Regarding financial barriers, a lack of financial resources, higher (investment) costs, and unpredictable financial performance all have to be taken into account (Vermunt et al., 2019). The lack of financial resources can become a problem because it can lead to proportionally expensive debt that can reduce the manufacturer's profit margins (de Jesus Pacheco, ten Caten, Jung, Sassanelli, & Terzi, 2019). The higher costs are a problem mainly due to high investment costs (Neely, 2009). This problem is illustrated by an example of a manufacturer in the clothing industry: the manufacturer is growing rapidly, resulting in higher need for capital, but a relatively small amount per month is received in the PSS construction (Vermunt et al., 2019). Lastly, the unpredictable performance is an obstacle within the PSS construction. This is often due to the lengthy contracts associated with PSS constructions. Manufacturers have difficulties in valuing the product over a long period (Neely, 2009) because it is hard to predict the demand. For example, a study of a furniture manufacturer indicates that, due to fashion trends, they are unable to accurately estimate where the market will go over a more extended period and thus cannot adequately cover the high financial risk (Besch, 2005). In other words, a lack of financial resources, high investment costs, and uncertainty of long-term financial performance are categorized as financial barriers.

The internal organizational barriers include an administrative burden, a change in the organization's infrastructure, and more complex planning processes (Vermunt et al., 2019). However, there seems to be an overarching problem within organizations, namely, the fear of change (Mont, 2002). Manufacturers seem to have an orientation from design and maintenance in contrast to customer orientation (Kohtamäki, Einola, & Rabetino, 2020). This is not that surprising when one takes into account that there is often an intermediary between the manufacturer and the end-user, such as a wholesaler or, in the construction industry, a contractor who is customer-oriented on behalf of the

manufacturer. The manufacturer, therefore, has, as it were, a lack of knowledge of service design (Annarelli, Battistella, & Nonino, 2016). Some manufacturers try to overcome this by placing an extra B.V. next to the production B.V. in which the service B.V. entirely concentrates on the service components (Baines et al., 2019). However, problems arise here as well. For example, an industrial equipment manufacturer indicates that their customers do not know when to communicate with which B.V. if they experience problems with the product (Gustafsson, Edvardsson, & Brax, 2005). In other words, from an organizational point of view, there are challenges such as the change in infrastructure and the associated administrative burden, as well as the reluctance to change the existing culture.

The last internal barrier concerns the barrier "knowledge and technology". According to Vermunt et al. (2019), organizations have a lack of data and lack of technical knowledge. While data has a positive effect on servitization in both the exploration and exploitation phase (Coreynen, Matthyssens, Vanderstraeten, & van Witteloostuijn, 2020). In the exploitation phase, the data can focus on scaling up and setting up more efficiently the products and services to be delivered, and in the exploration phase, data can provide insights into new services or other revenue models (Coreynen et al., 2020). When exploring new business models, think of a TomTom that goes from selling its navigation to selling its data. The lack of technical knowledge is not just about knowledge of the design of the product, but there is also a lack of knowledge in areas such as; servitization, knowledge of regulations, and a lack of insight into the financial consequences within the organization (Guldmann & Huulgaard, 2020). In other words, organizations have insufficient data available, and there is a lack of knowledge in essential areas within servitization.

In summary, a distinction can be made between three different internal barriers: financial, organizational, and knowledge and technology related barriers. Within the financial barrier, there is a lack of financial resources, high investment costs, and uncertainty about the financial performance of the concept in the long run. Within the organizational barrier, the culture and infrastructure of the manufacturers need to change. Concerning knowledge and technology, there are insufficient data to support the exploitation and exploration phase, and there is a lack of knowledge in critical areas within servitization.

3.2.2 External barriers in the transformation

In addition to internal barriers, a distinction can also be made between three categories of external barriers. These are barriers originating from the supply chain, the market, and the regulations (Vermunt et al., 2019). Table 5 provides an overview of the external categories created by Vermunt et al. (2019). In this chapter, these external barriers are discussed in more detail.

Table 5 External barriers

External barriers	Description of barriers
Supply chain	Lack of partners and low availability of materials
	Higher dependence on external parties
	Lack of information exchange between supply chain actors
	Conflicting interests between actors in the supply chain
Market	Lack of consumer interest
	Resistance from stakeholders with vested interests in the linear economy
Regulations	Specific current accounting rules and management systems that are inappropriate for to the circular economy

Concerning the supply chain barrier, the challenge is that within the PSS model, there is a higher dependency on external partners, but there are also conflicting interests and lack of information between these partners (Vermunt et al., 2019). However, there is little possibility of avoiding external partners because there are few organizations that can roll out a concept entirely on their own (Baines et al., 2007). Therefore, appropriate contracts are necessary between the manufacturer and the external partners in order to eliminate the financial risks and uncertainties among the stakeholders (Besch, 2005). External partners also have to be involved in the design of the product (Mont, 2002): they have to learn from the manufacturer because they need the expertise to offer a high-quality service to the end-user (Gustafsson et al., 2005). However, one can assume that the fear of change is present here too and that a cultural transformation has to take place both among the manufacturer and the external partners (Annarelli et al., 2016).

However, because there is still uncertainty about the financial consequences (described in financial barriers), there is a reluctance on the part of the manufacturer's external partners, and a cultural change does not take place quickly among them (Luthra, Kumar, Kumar, & Haleem, 2011). In other words, there may be resistance within the chain due to conflicting interests, but also because the manufacturer has not solved its financial barriers.

Regarding the external market barrier, according to Vermunt et al. (2019), consumers and other stakeholders do not accept the PSS concept because they are not interested in a circular economy. Perhaps this is because they do not understand the total cost of ownership/use (Tan, 2018). In contrast, while directors do see the importance of the total cost of ownership/use, they often do not see the importance of the product that the other layers in the organization understand (Gustafsson et al., 2005). In addition to acceptance, the purchase process is often too complicated, and the argument that there is a shift from use to ownership does not always seem to hold in practice (Mont, 2002), even though it does seem that countries such as the Netherlands, Switzerland, and Scandinavian countries are relatively open to such concepts (Baines et al., 2007). In other words, the market is not yet mature enough to demand the PSS concepts.

Concerning the regulations, there may be articles in the law that obstruct PSS concepts (Vermunt et al., 2019) despite the need for PSS-friendly laws to promote a sustainable society (Kuo, Ma, Huang, Hu, & Huang, 2010). Unfortunately, the literature review has revealed no research as to which articles of law influence the transformation from product-oriented to service-oriented business models in the construction industry. Because there is a chance that such research exists, they are taken into account in this research.

In summary, external barriers can be divided into three categories: barriers originating in the supply chain, in the market, and in regulations. There may be resistance within the chain because there may be conflicting interests, but also because the manufacturer has not solved its internal barriers. The market is not mature enough to demand the PSS concepts. There may also be regulations in place that impede PSS concepts.

3.2.3 Stimulating factors in the transformation

In addition to the barriers, the literature also describes several stimulating factors on the transformation process. These factors can be divided into internal and external stimulators, known as variables within the organization as internal stimulator and variables within the supply chain and the market as external stimulators of the transformation process. The following paragraphs explore these stimulators in more detail. The first three paragraphs will concentrate on variables within the organization the last three paragraphs will discuss the supply chain.

Regarding the internal organizational factors, according to Baines & Lightfoot (2013), the organization needs a strong leader who understands the concept of servitization well. Unfortunately, the literature on servitization does not describe what other characteristics such a leader should have. A research study related to a service organization suggests that such a leader should have a high capacity for innovation, connectivity and be active in networking (Lee, Kim, Noh, & Lee, 2010). As described in the previous paragraphs, there is a lack of knowledge in the areas of servitization, regulation, and financial consequences. It is thus expected that such a leader also has knowledge in these areas. In other

words, the manufacturer must have a strong leader who is familiar with the concept of servitization, and who is innovative and active in connecting people.

In addition to the strong leader, the manufacturer should also have two business units, one unit focusing specifically on service and the other one on the traditional manufacturing of the products (Baines & Lightfoot, 2013). Within the service-oriented business unit, several teams are made up of team members who are freethinkers and relationship builders. Within these teams, there should be a culture of "zero defects." They must prioritize the life cycle value of the customer (Reichheld, 1990) rather than the one-off transaction. When striving for zero defects, the quality of service and its life cycle value are increased. In other words, the manufacturer should consist of two business units, one of which concentrates on production, and the other one on service. Each unit requires a different organizational structure with corresponding employees.

These two units need to communicate well with each other. For this reason, the manufacturer must have an information and communication system in which the advanced services can be understood and measured (Baines & Lightfoot, 2013). Such systems exist and are part of the workflow management systems in which quality, costs, and time are recorded (Cardoso, Sheth, Miller, Arnold, & Kochut, 2004). Concerning these systems, trends such as industry 4.0 and big data will become more important than before (Lee, Kao, & Yang, 2014). An essential element in this process is that everything is monitored to gain insights for improvements towards maximum quality (Reichheld, 1990). Through data, the aim is not only to achieve maximum quality in the exploitation phase of the concept but also in the exploration phase (Coreynen et al., 2020). Thus, the software-related systems are essential to support advanced services.

Concerning the external category "supply chain", the manufacturer should increase the emphasis on vertical integration in the supply chain (Baines & Lightfoot, 2013). For example, in the traditional situation, the manufacturer will design and produce. When transferring to a service-oriented BM, the product design is shifted closer to the customer. The manufacturer can achieve this using the two business units where the design belongs to the service-oriented business unit and the production to the product-oriented unit. Figure 5 clarifies this process.

The process has three main characteristics. First, the service unit is in the form of a matrix-style management structure that deals with advanced services. Second, the design process is more closely linked to the customer and, third, the long-term contracts are concluded with intermediaries in the chain (Baines & Lightfoot, 2013). However, it has to be taken into account that in

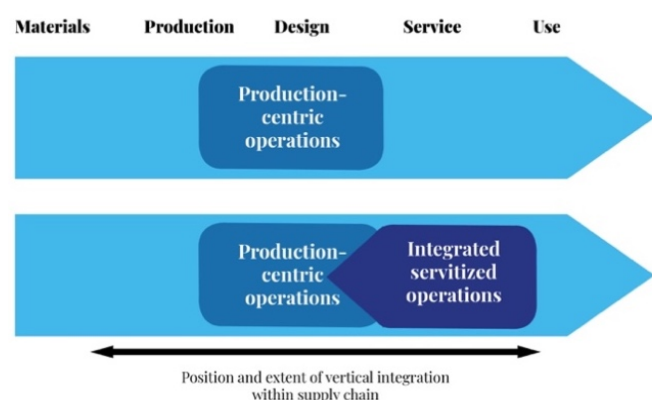


Figure 5. The process of servitization. Adapted from *Made to Serve: How Manufacturers can Compete Through Servitization and Product Service Systems*, by T. Baines, 2013

the sample of machine manufacturers in Oliva and Kallenberg (2003), there was little support for the success of vertical integration and instead, there was support for horizontal integration, where manufacturers gather a network of service parties around them. In other words, to make a shift towards a more service-oriented BM, it is suggested that the manufacturer should engage in vertical integration. However, this could depend on context, as no evidence has been established for this in another study.

Similar to the supply chain, according to Baines & Lightfoot (2013), the customer has to accept a service model and be prepared for a long-term relationship. This relationship with the customers can be strengthened by scheduling multiple touchpoints with them. Thus, the manufacturer should not only be customer-oriented but it should cooperate with and learn from the customer as well (Vargo & Lusch, 2014). This cooperation can be stimulated by strategic geographical positioning of the service unit or the partners responsible for the customers. The service unit needs to be structured according to a matrix-style structure (Baines & Lightfoot, 2013), which means that employees from different departments work on the same team. However, there are profits to be gained not only from the existing customers but also from the customers who have left. These customers are more likely to point out errors in the product or service to the organization (Reichheld, 1990). Thus, the customer should be open to a long-term relationship, which can be strengthened by multiple touchpoints, geographical positioning, and a matrix management style.

Table 6 Stimulators

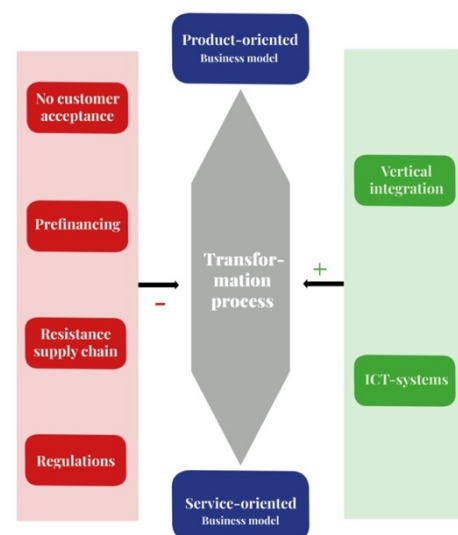
Stimulators	Description stimulators
Organization	Strong leader
	Two SBU
Supply chain	Vertical integration
	Horizontal
Market	Long term relationships
	Multiple touchpoints

3.3 Conceptual model

This research will investigate the configurations of inhibiting and stimulating factors in servitization. In order to arrive at reliable configurations, it is important that the variables are theoretically substantiated. In this research this substantiation has been protected as much as possible by systematically reviewing the literature from reliable journals. However, it are these different studies that demonstrate that reality is more complicated than a one-to-one relationship. For example, the literature review already revealed that, according to Baines & Lightfoot (2013), vertical integration could be a possible stimulating factor, and according to Oliva & Kallenberg (2003), horizontal integration has a positive effect. It is this complexity that makes it challenging to analyze all variables simultaneously. According to Ragin & Rihoux (2009), this complexity can be dealt with by first selecting the variables that are most likely to be relevant. To then, formulate a new strategy with more epistemological criteria and include the other variables. However, the time span of this research has to be taken into account, and it is not realistic to formulate an additional strategy. Therefore, the variables with the most relevance have been retained. In other words, the variables in the conceptual model from this research are theoretically justified and are based on the most relevant variables.

To determine the relevance, the year of the publications and the number of citations of the articles were taken into account. Thus, the inhibiting and stimulating factors from Baines & Lightfoot (2013); Vermunt et al. (2019); Coreynen et al. (2020), research are integrated into this conceptual model. This model is illustrated in figure six on the right.

Figure 6. Conceptual model



4. Methods

In order to investigate the configurations of inhibiting and stimulating factors in the servitization transformation process, this research makes use of qualitative data. Qualitative research can have multiple purposes, such as exploring, raising awareness, evaluating, or testing theories (Drisko, 2005). Qualitative research is characterized by analyzing and interpreting the text in order to arrive at possible new hypotheses (Auerbach & Silverstein, 2003). Because this research is aimed at exploring the configurations of factors, the qualitative method is appropriate for it.

The data in this study were collected through multiple interviews with different organizations, and the interviews of two or more different cases will be compared with each other (Bell et al., 2018). A comparative method has been chosen in order to gain a clearer insight into which factors are unique

and which factors are common in the transformation process. In the following paragraphs, a more detailed description is provided of the organizations involved in this research, the reasons for selecting them and the selection method, the data sources used, and the method of analysis (Cooper, Schindler, & Sun, 2006).

4.1 Sample

The organizations involved in this research are small and large manufacturers in the construction sector in the Netherlands. The sample is divided into two groups. One group consists of manufacturers with a product-oriented BM and the other group are manufacturers with a more service-oriented BM. It is difficult to determine precisely whether a manufacturer has a product-oriented or service-oriented BM. For example, is the criterion for a service-oriented BM if revenues are generated through use, if the ownership of the product remains with the manufacturer, or if the manufacturer enters into a commitment with its customer for an extended period? And, to what extent should such criteria be present? For instance, does one characterize a BM as service-oriented if the projects that fall under it also contribute to a certain percentage to the turnover? And what if the manufacturer has different combinations of product and service strategies (Burton, Story, Raddats, & Zolkiewski, 2017). Thus, there are different ways one can use to categorize a manufacturer with a service-oriented BM.

The literature has not made it clear how to determine which phase of servitization process an organization is in. Furthermore, if one assumes that the transformation is not linear (Baines et al., 2019), then it is even more difficult to categorize the degree of servitization for manufacturers. This study adheres to the basic principles of the servitization of Vandermerwe and Rada (1988), as described in the theoretical framework section. These principles have been translated into the usual contracts in the construction industry (section 2.4), and an attempt has been made to link these contracts to Vandermerwe and Rada's theory (1988).

Table 7 Categorization sample

Sample selection				
Groups	Definition	Criteria	Contract	Reference
Product-oriented	Focused on the traditional sale of the product with the addition of additional services.	- Tangible product	DB	Baines et al., 2007
		- Installation	DB	
		- Repair	DBM	Vandermerwe & Rada, 1988
		- Training	DBM	
Service- oriented	<i>"an outcome focused on capability delivered through performance of the product"</i>	- All above and:		Baines & Lightfoot, 2013, p. 66
		- Revenue through use	DBFM	Vandermerwe & Rada, 1988
		- Rental agreement		
		- Self service	DBFMO	

Table 7 provides more clarity on the links between the theory and the contracts in the construction industry. Manufacturers were categorized based on criteria such as whether revenue was

generated through use or rent, or whether there was self-service. These criteria come from Vandermerwe and Rada (1988) and Baines et al. (2007), studies that were selected for two reasons. First, Vandermerwe is the founder of servitization, and second, the authors of both studies are frequently cited and have published in reputable journals. In other words, the two groups in this research have been divided based on criteria such as income by lease or rent or the presence of self-service. An example of self-service would be a sluice that is placed, maintained, and operated by the manufacturer. By way of illustration, the groups with corresponding criteria are listed in table 7.

The division into two groups made it possible to compare more accurately different configuration of inhibiting and stimulating factors. This provided a clear overview of which inhibiting factors have been solved by the group of service-oriented manufacturers, as opposed to the group categorized as product-oriented, where the inhibiting factors have not been solved. It also revealed which factors were present in the group of service-oriented manufacturers but not in the group of product-oriented manufacturers and which may, therefore, be identified as stimulating factors. It is worth mentioning that both groups of manufacturers in the sample were seeking a service-oriented BM. While one group was at the beginning of the servitization process (product-oriented), the other group had already implemented a service-oriented BM(service-oriented).

Because of the qualitative nature of this research, theoretical sampling was used to discover factors that describe relationships in theory (Bell et al., 2018). In contrast to striving for representativeness, theoretical sampling is about adding something unique to the results. This may be a replication of results from other studies, but also the fact that the case in question brings something unique to the phenomenon under investigation (Eisenhardt & Graebner, 2007). The addition of something unique to the phenomenon (the transformation) is the reason that there are some differences between the manufacturers in the sample. More information about these differences can be read in the next paragraph. In other words, this study used theoretical sampling and investigated unique and common elements. The following section describes types of manufacturers included in the sample.

4.1.1 Description sample

The sample consisted of 13 manufacturers from the construction sector. The number of 13 was determined because, after 11 cases there are, on average, repeats in the answers (Guest, Bunce, & Johnson, 2006). However, the number of 11 cases is an average, and this study wanted to take a margin into account. Therefore, this study focused on a total of 13 cases instead of 11. Based on the criteria mentioned above (Table 7), manufacturers were divided into two groups; nine manufacturers were categorized as product-oriented and four as service-oriented. Within this sample, there was a difference in the manufacturers' focus: four manufacturers focused on infrastructure, and nine focused on non-residential construction. Among the manufacturers that focused on non-residential construction, the products varied from suspended ceilings to elevators. Even though the manufacturers did not form a fully homogeneous group, they were nevertheless all manufacturers in the construction sector. To

illustrate the point, one of the variables is customer acceptance. Both the manufacturers focusing on infrastructure and those focusing on non-residential construction have customers such as contractors, project developers, or investors, and both have to deal with (more or less) the same customer acceptance.

Thus, even if the manufacturers seem to be different, they can give similar results. However, when interpreting the results, it is important to determine the extent to which the outcome is only relevant for a particular company (Siggelkow, 2007). In this study, the sample consists of 13 construction manufacturers, with four manufacturers focusing on infrastructure and nine on non-residential construction. Based on the criteria in this study, it can be concluded that nine of the 13 manufacturers are categorized as product-oriented and four as service-oriented.

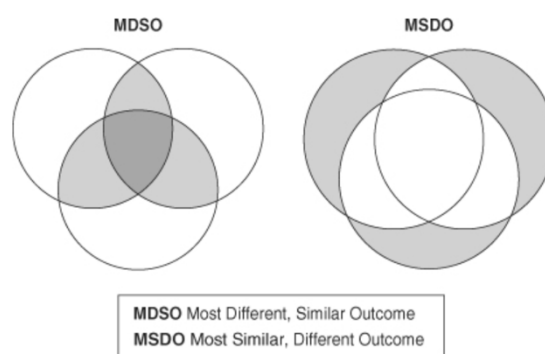


Figure 8. Most Different and Most Similar Systems Designs. Reprinted from *Configurational comparative methods*, by C. Ragin, 2009

Besides the difference in the manufacturers' focus, there was also a difference in size among the participating manufacturers. The reason for this is that by studying relatively larger manufacturers (where the concept is already at an advanced stage), insight could be gained into the stimulating factors. The combination of large and small companies may lead to more balanced empirical research (Collinson & Rugman, 2010). To determine when a company is relatively large or small, the separation of >3,000 employees has been applied for the largest companies. This separation criterion was taken from Neely (2009). However, the difference between 1 and 3,000 employees is relatively large. That is why manufacturers with 250-3,000 employees were characterized as medium-sized. The division into SMEs comes from the study (Valtakoski & Witell, 2018). These studies were elected because they both focus on servitization, and they have been cited relatively often. Based on this division, this study had four large companies in the sample, six medium-sized, and two small.

In summary, within the sample of 13 manufacturers, there were differences in focus and size. These differences were analyzed to gain different insights. However, the size of the sample has been taken into account. Problems can arise if there is a combination of total differences in a small sample (Seawright & Gerring, 2008). In this study, differences are used, but not total differences, so that this may not cause problems for the relatively small sample of 13 manufacturers. Table 8 provides an

overview of the numbers described in this section. The next section explains how the companies were selected.

Table 8 Overview cases

CaseID	Stage	Orientation	Size
Case1	Service-oriented	(Non)-residential construction	Large
Case2	Service-oriented	Infra	Large
Case3	Service-oriented	Infra	Large
Case4	Service-oriented	(Non)-residential construction	Large
Case5	Product-oriented	(Non)-residential construction	Medium
Case6	Product-oriented	Infra	Medium
Case7	Product-oriented	(Non)-residential construction	Medium
Case8	Product-oriented	(Non)-residential construction	Medium
Case9	Product-oriented	(Non)-residential construction	Large
Case10	Product-oriented	(Non)-residential construction	Small
Case11	Product-oriented	(Non)-residential construction	Medium
Case12	Product-oriented	(Non)-residential construction	Medium
Case13	Product-oriented	Infra	Small

4.1.2 Selecting sample

As described earlier, this study used a sample that includes only manufacturers active in the construction sector in the Netherlands. This industry was chosen because the literature has already provided insight into other industries (Rizos et al., 2016). An industry insider explained before the study that the construction industry, which is complex because of its many stakeholders and capital-intensive products, was considering a shift towards service-oriented business models. The Dutch market was chosen because, according to Baines (2007), the culture within the Netherlands, Switzerland, and Scandinavia is relatively open to accepting a service structure. In other words, the construction sector was chosen because of the expected complexity, and the Dutch market was chosen because the Dutch culture is expected to accept a service-oriented construction more quickly.

In order to determine which manufacturers in the construction industry were in the process of transforming from product-oriented to service-oriented business models, the author searched Google and attended events such as the "Company Days of Twente", "Circularity in the manufacturing industry" and "Circular manifesto" to find manufacturers willing to participate in the research. Meetings were also held with intermediaries in the construction sector to discover more manufacturers in this field. Afterwards, the relevant manufacturers were contacted via the intermediaries and asked by telephone or e-mail whether they were open to participating in the study. Based on the criteria in Table 7, an attempt was made to obtain an indication of which BM orientation the companies adopted. In order to increase the reliability of placing the manufacturers in the correct category, control questions were asked at the beginning of each interview.

Respondents were interviewed in order to get more clarity about the companies. In this study, companies are the unit of observation and the transformation to a service-oriented BM is the unit of analysis. All respondents were involved in the transformation of the business model of the companies they worked for. In most cases, these respondents had a job title of commercial director or manager.

Thus, the data were collected from commercial managers or directors of the construction industry who were involved in the transformation of their companies' business models.

4.2 Operationalization

As described in section 4.1, the respondents in this study were divided into the product-oriented and service-oriented groups. The service-oriented group consisted of companies that provide a combination of services that meet the definition of advanced services by Vandermerwe and Rada (1988) and the PSS definition by Baines et al. (2007). This means that respondents who undertook projects with DBFM(O) contracts were among the service-oriented companies. In the QCA, this group was calibrated to 1 and the product-oriented group to 0, and together they formed the variable "stage" in the analyses. More information about the QCA can be read in section 4.4.1.

As described in the conceptual model section, six variables have been examined in this study. Four of them are possible barriers, and two have a possible stimulating effect. For the inhibiting variable, a 1 was generated when the respondents did not see it as an obstacle to servitization, and a 0 when they did see it as an obstruction. For the stimulating variable, the variable was present when the respondent received a 1 and otherwise a 0. More information about the interview protocol is presented in section 4.3 and more information about the way of analyzing the 0 and 1 can be read in section 4.4. It is essential to note that the numbers 0 and 1 are generated based on the respondent's perception and not on percentages. To conclude, six variables have been examined in this study. When the inhibiting variable was solved it was given the value of 1, otherwise it was coded as 0. When a stimulating variable was present, it was given the value of 1, and when it was not present, it was given a value of 0. Table 9 below provides an overview of the figures described above.

Table 9 Operationalization table

Factors	Variables	Present	Resolved
Inhibiting	<u>(1) Pre-financing</u>	0	1
	<u>(2) Supply chain</u>	0	1
	<u>(3) Customer acceptance</u>	0	1
	<u>(4) Regulations</u>	0	1
Factors	Variables	Not present	Present
Stimulating	<u>(5) Vertical integration</u>	0	1
	<u>(6) ICT systems</u>	0	1

4.3 Data collection

In order to collect data, semi-structured interviews were conducted with the commercial managers or directors of the selected companies. This means that several questions were defined before the interviews (Baarda et al., 2013) because the research is deductive. This means that the inhibiting or stimulating factors in the transformation have already been described in theory and that this study examined whether these factors also applied in the construction industry. While structured interviews were an option, semi-structured interviews were used to uncover any additional variables and gain a broader understanding of the variables influencing the transformation. In short, the data to be collected from the respondents are semi-structured interviews.

The structure of the semi-structured interviews is set out in Appendix I. The interview started with a general introduction to the structure and purpose of this study. Subsequently, the interviewees were asked the screening questions. The purpose of these questions was to check whether the person interviewed was involved in the transformation of the BM and whether the company was classified in the right category. These questions correspond to the criteria in Table 7. In other words, based on the screening questions, it was checked whether the respondent is involved in the transformation of the BM and whether the manufacturer can be categorized as product or service-oriented in this study.

Subsequently, the inhibiting and potentially stimulating variables were discussed. These variables are highlighted in Appendix I by an underscore (e.g. the variable (1) pre-financing). All six variables in Appendix I were input variables for the QCA analysis. In the QCA analysis, however, variables are referred to as “conditions” (Ragin & Rihoux, 2009). For this reason, the variables are henceforth referred to as conditions. More information about the QCA analysis can be read in the next paragraph.

A total of six conditions are analyzed. For some conditions, in-depth questions have been asked in order to provide a possible explanation for the inhibiting or stimulating conditions later in the results. Because this study aims to provide a definitive "yes" or "no" answer in order to measure the conditions, the last question associated with a condition is a conclusion question. This question should be answered with a yes or no. Subsequently, the number 0 or 1 is linked to the answer 'yes' or 'no'. These numbers correspond with the processing of QCA. More information about the analysis of QCA can be read in chapter 4.3.3. In other words, the semi-structured interview started with control questions about the respondent and the company and was followed by a substantive discussion about the conditions.

All interviews were conducted in the period from April to May 2020. To facilitate the analysis, all interviews were recorded and transcribed using the Amberscript program. To ensure that the program correctly transcribed the spoken data, the entire interviews were listened to one more time and mistakes in the transcript were corrected manually. The advantage of transcription is that at a later stage of the study the transcripts can be reviewed to gain a deeper understanding of the phenomenon (Basil, 2003).

Prior to the interview, all respondents were asked whether they objected to being recorded and the interviews transcribed. In other words, the semi-structured interviews were conducted in the period from April to May and recorded on audio in order to be processed into transcripts.

4.4 Data analyses

As described in the previous section, all interviews were transcribed, and the conditions were measured by asking a closing yes-no question. As described in the introduction, this research was aimed at exploring the configurations of inhibiting and stimulating conditions in the transformation process from a product-oriented to a service-oriented BM. It was thus interesting to see to what extent certain conditions (inhibiting and stimulating conditions) were sufficient or necessary. A sufficient condition means that another condition can compensate for it and that they both have an effect on the outcome. Necessary condition must be present and cannot be replaced by other conditions, and without it, the process is doomed to fail (Dul, 2016). A suitable analysis method to determine the combination of the independent conditions is QCA (Ragin & Rihoux, 2009).

Although QCA should be able to analyze sufficient and necessary conditions, this study used the Necessary Condition Analysis (NCA) as well. The main difference between QCA and NCA is that QCA looks into the effect of combinations of conditions on the outcome and NCA is based on the single condition as effect on the outcome (Dul, 2016). Because of this difference, the two analyses can complement each other. After clarifying the sufficient and necessary conditions, it was explored as to why these conditions inhibit or stimulate the transformation. By coding the 13 transcripts, an attempt was made to gain a deeper insight into the results from the QCA and NCA. In other words, the data were first analyzed using the QCA. Afterwards, NCA was used to check for any necessary individual conditions. Finally, using coding, an explanation was sought for the QCA and NCA results.

Section 4.4.1 provides more explanation about QCA and the steps taken in this analysis. Section 4.4.2 describes the NCA. Section 4.4.3 describes the coding method. Section 4.5 describes the steps taken to ensure the trustworthiness of this study.

4.4.1 Qualitative comparison analysis (csQCA)

As can be seen from the central research question, this study was envisaged as a configuration study. In contrast to traditional studies, a configuration study focuses on the relationship between the independent variables, and these variables are not seen as separate variables influencing the dependent variable (Fiss, Cambré, & Marx, 2013). One of the focal techniques in a configuration study is the QCA technique. This technique can have different purposes, such as summarizing data, checking the coherence of the data, checking hypotheses, or confirming existing theories (Ragin & Rihoux, 2009). In other words, the QCA technique corresponds well with the intended purpose of this research.

The QCA technique is not based on the fundamental assumptions such as permanent causality, homogeneity of the sample, and causal symmetry of the variables. Because of the lack of these

assumptions, it is not possible to describe the results as true causal relationships (Ragin & Rihoux, 2009), so any follow-up research would have to test the results from this study statistically. However, the size of the sample should be considered. According to Fiss et al. (2013), QCA works reliably with relatively small sample sizes, such as a sample size smaller than 30 cases (Ragin & Rihoux, 2009). However, the conditions must be supported theoretically. In this study, 13 cases were examined, and the conditions from earlier studies were operationalized as much as possible.

There are different types of techniques within QCA, such as csQCA, fsQCA, and mvQCA. csQCA runs based on dichotomous conditions. mvQCA is an extension of the csQCA, where the technique runs on categories. fsQCA runs on interval conditions and is therefore suitable for a more accurate analysis. However, this research aimed to explore the configurations in the construction industry. An accurate analysis was relatively difficult because several conditions at the beginning of the study were not known, such as the regulations in the construction industry. In this study, the data were formed based on "yes" and "no" answers, thus making them dichotomous. Thus, csQCA was selected as the most appropriate of the three techniques, but it must be taken into account that these results are less accurate than the fsQCA results.

CsQCA execution

The csQCA analysis was conducted in five steps. **First**, the dichotomous table was drawn up. In this step, the six conditions were calibrated to arrive at 0 and 1 values for the truth table in step two. This calibration of the conditions is based on the conclusion questions in the semi-structured questionnaires that can be read in Appendix I. The first condition is the condition (1) pre-financing. The reasoning for the calibration of this condition is that if pre-financing is required, three scenarios are imaginable. For example, the pre-financing must come from 100% equity or 100% debt, or there is a combination of equity and debt. Based on these three scenarios, the final question in the interview was whether pre-financing is a problem (Yes 0, No 1).

The second condition is (2) supply chain. The purpose of this conditions was to discover whether the partners with which the manufacturer has to collaborate are open to a product as a service concept. The first objective was to determine the partners of the manufacturer. The interviewees were then asked whether these partners were resistant to the concept and whether there were differences among partners in this respect. In the end, a final question was whether there was resistance within the supply chain towards the concept or not (Yes 0, No 1).

The condition (3) customer acceptance was aimed at determining whether the market supports the service concept. In this condition, the first question was who the customers were, and an attempt was made in the coding phase to determine whether certain customer segments might be more open to the product as a service concept than the other customer segments. If the respondent did not know why their customers might or might not be open to such a concept, they were asked about aspects such as "preference for ownership" or "striving for the total cost of ownership/use" to gain a better insight into

why the customer may or may not be open to the concept. Finally, the conclusion question was asked whether customers were interested in the product as a service concept (Yes 1, No 0).

The condition (4) regulation aimed to discover if any regulations made a product as a service concept not feasible in the construction industry. Unfortunately, there were no concrete examples in the literature, only suggestions that regulations could be a problem. For this reason, the respondents were asked whether any regulations inhibited the concept and, if so, what these regulations were and whether the respondent created a solution to these regulations. In cases where specific regulations were discovered at a later stage in the data collection process, previous respondents were asked by e-mail how they solved the potential barrier. Concluding question was whether there were any regulations that impeded the product as a service concept (Yes 0, No 1).

The condition (5) Vertical integration aimed to discover whether design, building, and maintenance were all under the manufacturer's control. The respondents were also asked whether the production and the maintenance in particular were legally separated from each other in order to minimize the risks. The final question was whether the design, construction, and maintenance were all under the company's control (No 0, Yes 1).

The condition (6) IT systems aimed to determine whether companies had sufficient insight and substantiation through data for the product as a service concept. For this purpose, the participants were asked whether the ICT systems were present for the three disciplines and how long these ICT systems had been collecting data for. If the ICT systems were present for a relatively short period or if the data were encrypted so as to render it unusable, the condition was labeled as "not present" (Not present 0, Present 1).

The second step was the truth table constructed using software by Drass et al. (1992). In this step a distinction was made between relevant and irrelevant cases. In this study it was decided to keep a number of 1 to 2 cases for a configuration. This number was chosen because it is recommended for relatively small samples (Drass et al., 1992). In order to realize this, the column "numbers" was sorted in the descending order in the software. The rows in the column "numbers" below the threshold of 1 were identified as irrelevant and removed from the truth table. Next, the column "raw consistency" was sorted in the descending order. In this way, an overview was created of the consistency threshold that could be used in this study. This threshold is somewhat subjective because the researcher determined it himself based on his knowledge of the case and the theory. In order to increase the objectivity, common threshold values were examined. The literature generally uses thresholds between 0.75 and 0.90 (Drass et al., 1992). In other words, in order to prepare the truth table for analysis, irrelevant cases were first removed from the table and threshold values of 0.75 were chosen, but an interesting consistency of 0.6667 was detected in the results and it was decided to keep it in the truth table. More about this can be read in the results.

Third, the analysis has started, and no contradictions have been discovered [C]. However, the analysis was first performed without any logical remnants being included in the analysis. The analysis

was performed without any logical remnants so that multiple configurations might be discovered. This approach is also called the intermediate solution. According to Ragin & Rihoux (2009), the intermediate solution is a balance between the complex and parsimonious solution.

Fourth, the analysis was performed again, but now with logical remainders (parsimonious solution). In this step, the software added unobserved cases based on logical values. The advantage of the method with logical residues, as opposed to the method without logical residues, is that the formulas are less complex, and insight is gained into the necessary conditions (Ragin & Rihoux, 2009). The software conducted this analysis by excluding the remainders. Thus, two analyses were conducted: first without logical remainders and then with logical remainders (intermediate and parsimonious solution).

Finally, an attempt was made to interpret the configurations and understand the explanation of the configurations. To discover the explanation of the configurations, the 13 transcripts were encoded. More information about encoding can be read in section 4.4.3. The next paragraph first describes the NCA. Before examining the configurations in more depth, it was necessary to gain more certainty about the necessary conditions. The next paragraph thus first provides more information about the NCA. In other words, before the QCA results could be interpreted, NCA was conducted, and then, through coding, the underlying logic of the configurations was determined.

4.4.2 Necessary conditions analysis (NCA)

In the first paragraph of the method section, NCA was described as an interesting addition to QCA because NCA tests the conditions individually whereas QCA analyzes the effect of a combination of conditions on the outcome. NCA thus calculates whether condition X is present in the successful case and absent from the unsuccessful case. If this is the case, X can be characterized as a necessary condition (Dul, 2016). In other words, NCA calculates which barriers have been resolved by the group categorized as service-oriented and which possible stimulating factors are present in this group compared to the group categorized as product-oriented.

NCA was conducted with the same software as that used for the QCA. In the software, the conditions are placed in the column "conditions" and in the column "outcome" the condition "stage" is placed. The software then calculates the consistency and coverage of each condition. Consistency refers to the extent to which a condition is present in the outcome. To illustrate, condition X may be present twice in the group of companies that are service-oriented (consisting of four companies altogether). The consistency in this case is 0.5 ($2/4=0.5$). The coverage in this example is lower because four is divided by the total sample ($4/13=0.3$). In other words, the consistency indicates through percentage the extent to which the condition is present within the group that is categorized as service-oriented, and the coverage indicates through percentage the extent to which the condition is present within the total sample.

It should be remembered that there are always limitations. For example, both with QCA and NCA, it should be kept in mind that these are observations that have been translated as accurately as

possible into a number 0 or 1. When the number of group cases is relatively small (six in this case), the presence of possible measurement errors must be considered. By way of illustration, in the above example, the consistency was 0.5 for condition X. Suppose in one of the four cases condition X was interpreted differently; in this case, the consistency may be considerably lower ($1/4=0.25$). Even when the consistency of 1 is reached, this does not mean causality. Indeed, there may still be other conditions present that may influence consistency. In other words, even though NCA helps one gain more insight into the necessary conditions, measurement errors and the fact that consistency is a correlation and not a causality should always be taken into account.

4.4.3 Coding

In order to gain a deeper insight into the necessary and sufficient conditions, all transcriptions were re-read and encoded to determine how many respondents explained the conditions in the configuration. The encoding technique was an open, axial, and selective approach. The purpose of open coding is to provide new insights. Axial coding investigates to what extent the categories can be linked to the results of open coding (Corbin & Strauss, 1990). In this research, open coding was linked to the QCA conditions. Finally, selective coding was applied to determine whether the categories could be classified in the core category. The coding was conducted using the ATLAS.ti program to gain a deeper understanding of the transcripts. ATLAS.ti was chosen for this purpose is because *"no one is smart enough or intuitive enough to read a series of transcripts and directly see the patterns in them"* (Auerbach, 2003 p.31). Thus, the transcripts were encoded in three steps, starting with the condition and ending with a deeper understanding of the configuration.

In summary, the analysis process in this study was divided into three phases. First, the configurations were determined through csQCA. Secondly, it was determined whether the conditions in the configuration were necessary or sufficient using NCA. Finally, the 13 transcripts were coded to provide a possible explanation for the configurations or the necessary conditions.

4.5 Trustworthiness of the data

It is always debatable whether the data collected through qualitative research are reliable or valid because, unlike quantitative research, qualitative research not work with tests and probability values. However, four criteria should be taken into account in qualitative research: dependability for reliability, confirmability for objectivity, credibility for internal validity, and transferability for external validity (Shenton, 2004). The next four sections provide more insight into how these four criteria were addressed in this study.

4.5.1 Reliability

The degree of reliability means that if the research is repeated in the context of the construction industry using the same methods and the same respondents, the results should be almost the same

(Shenton, 2004). However, matching results exactly is difficult because of the passage of time. For example, the current global pandemic may lead to different perspectives. In other words, there will always be a degree of both common and unique outcomes.

However, in order to increase the probability of a common outcome, a saturation of the answers was sought. The research revealed that saturation occurs on average after 11 interviews were also retained (Guest et al., 2006). Details were also taken into account during data collection, and the method was written down in as much detail as possible in order to increase the transparency and replicability of the research (Shenton, 2004). In other words, complete reliability may never be achieved, but every effort has been made to increase the reliability of the research as much as possible. Reliability is associated with research objectivity, and the next paragraph addresses this issue in more depth.

4.5.2 Objectivity

Objectivity within qualitative research is also difficult to accomplish fully. According to Shenton (2004), the objectivity of research can be stimulated by extracting human skill and perception from it. QCA and NCA were conducted using software. However, it should be kept in mind that questionnaires are also designed by humans. Note that even though the human skill is taken out of the study, the small sample may contain measurement errors, and thus the robustness of the model may show shortcomings (Ragin & Rihoux, 2009). According to Stokke (2014), the robustness of the model can be tested by changing the threshold and randomly modifying several codes in order to conduct the analysis again. However, this study has only four companies that performed a DBFM(O) contract. This means that when code changes in the group of four, this change has such a substantial effect on the results and the robustness of the model. In other words, a completely objective research is difficult to realize in a qualitative research, but by using software an attempt has been made to extract a bias and thus increase the objectivity of this study.

Apart from the fact that an attempt was made to take the human skill out, it is also important to mention that this study was not conducted on the order of the respondents, which means that this study is completely separate from the respondents. In other words, there is a certain amount of objectivity for the results. The following paragraph discusses the internal validity in this study.

4.5.3 Internal validity

Internal validity is about whether the study measures what it is intended to measure. There are several ways to increase internal validity. One method is the use of triangulation, which has been used in this study by employing industry insiders (Shenton, 2004). Thus, in addition to the 13 respondents, two sources who work in the construction industry but are active elsewhere in the construction chain discussed the results. These two sources offered to discuss the results themselves, which increased the honesty of their contribution. In other words, through triangulation, an attempt has been made to strengthen the internal validity.

A second method of increasing internal validity is the "member checks" (Shenton, 2004). Before the questionnaire, an attempt was made to determine whether the respondents were active in the servitization through Google searches. The second check took place during the interview when screening questions were asked. During the examination of the conditions, a conclusion question was asked for each condition to check whether the answer was interpreted as the respondent intended it. In other words, three checks were undertaken in order to increase internal validity.

A final method of increasing the internal validity is the use of multiple measurements. Multiple measurements have higher validity form than the single measurements because multiple measuring elements determine the condition. Through factor analysis, it can be checked if these measuring elements indeed determine the condition. In other words, multiple measurements are a powerful method of guaranteeing internal validity.

There is thus little theoretical support for conducting a single measurement, and the choice for the use of single measurement in this study was based mainly on practical considerations. This study was conducted in a relatively short period, and the development of reliable multiple measurements takes considerable time and requires some experience. This does not mean that every study with single measurements has an internal validity problem. Namely, if the respondents are familiar with the terminology of the single measurement, this measuring instrument can also meet the internal validity requirements. In this survey, all respondents understood the concept and occupied relatively high positions in the organizations, which means that an above-average level of knowledge could be expected from them. In other words, despite the use of single measurements, the internal validity of this study is not necessarily low. The following paragraph discusses the external validity of the study.

4.5.4 External validity

External validity refers to the extent to which the results can be applied to the total population. It is always up for a debate to what extent qualitative research is representative of a total population because the results from one interview are situation-specific. According to Shenton (2004, p. 70), several elements should be taken into account when applying qualitative results to the total population:

- *the number of organizations participating in the survey and where they are located;*
- *any limitations on the type of people that contributed data;*
- *the number of participants in the fieldwork;*
- *the data collection methods used;*
- *the number and duration of data collection sessions;*
- *the period of time during which the data were collected.*

In this study, the data were obtained from 13 organizations located throughout the Netherlands. The respondents were in the process of implementing the concept in their organization, either with or in orientation. Because of the Covid-19 pandemic, no interviews were conducted face-to-face, only via image calling. The respondents were interviewed once, and one respondent was contacted

by mail afterward to verify several results. The data were collected over two months. Based on this information and the reader's experience in and knowledge of the construction industry, she can make a more accurate estimation as to the extent that the results apply to the total population.

5. Main themes

All answers to the conclusion questions from the semi-structured interviews were entered into the dichotomous table. To improve the transparency and replicability of this study, this table has been added in Appendix II. During the construction of the truth table, it was noted that there was a configuration with a raw consistency below the recommended limit of 0.75. As described in the methods section, this row should have actually been removed from the truth table. However, because it was mainly the infrastructure-oriented companies that created the configuration of 0.6667, the configuration was left in the analysis because it might lead to interesting insights. In order to more accurately estimate the effect of the configuration of 0.6667 on the total, the analysis was also performed without this row. This resulted in configuration [I], as can be seen in Table 11. When the analysis was performed with this row, this led to configurations [I] and [II], as can be seen in Table 12. Thus, while the guidelines prescribe that row two (configuration 0.6667) should have been removed from the analysis, by keeping it, it was possible to see a difference between infrastructure and non-residential construction-oriented manufacturers.

Table 10 Truth table

B.Prefinancing	B.Supplychain	B.customeracceptance	B.regulations	S.VerticalIntegration	S.ICTsystemen	Number	Stage	Raw consist.	PRI consist.	SYM consist
0	0	0	0	0	0	3	0	0	0	0
1	1	0	1	1	1	3	1	0.666667	0.666667	0.666667
0	0	1	0	0	0	2	0	0	0	0
0	0	0	1	0	0	1	0	0	0	0
0	0	0	0	0	1	1	0	0	0	0
1	1	1	0	1	1	1	1	1	1	1
1	0	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1

Table 11 Configuration [I]

Configuration	Raw coverage	Unique coverage	Consistency
B.prefinancing*B.supplychain*B.customeracceptance*S.VerticalIntegration*S.ICTsystemen	0,5	0,25	1

Table 12 Configuration [I] & [2]

Configuration	Raw coverage	Unique coverage	Consistency
B.prefinancing*B.supplychain*B.customeracceptance*S.VerticalIntegration*S.ITsystemen	0,5	0,25	1
B.prefinancing*B.supplychain*B.regulations*S.VerticalIntegration*S.Itsystemen	0,75	0,5	0,75

The analysis (intermediate solution) of the truth table indicated that there were two configurations that applied to a service-oriented BM (Table 12). Configuration [I] had a consistency of 1 which indicates that the service-oriented companies in this study that met the configuration have solutions for the barrier conditions of pre-financing, supply chain, customer acceptance, and stimulating conditions of vertical integration and ICT systems. Considering the raw coverage in configuration [I],

the conditions are present in 50% of the service-oriented companies in the sample. In other words, the companies that offer the product as a service:

- have no problems with pre-financing;
- experience no resistance in the supply chain;
- have a concept that is accepted by the customer;
- have own control in; design, installation and maintenance;
- have IT systems that generate data to provide insights into the behavior of the concept.

Configuration [II] is almost identical to configuration [I]. The consistency of configuration [II] is 0.75, which indicates that this configuration is present in 75% of service-oriented companies. The differences between configuration [I] and configuration [II] are the conditions "customer acceptance" and "regulation". These conditions are, therefore, responsible for the difference of 25% (consistency $1 - 0.75 = 0.25$). When considering the cases that are responsible for configuration [II], it is striking that these are all infra-related companies. In other words, within the construction industry, there is probably a difference between customers who are or who are not open to the concept, and within several cases of non-residential construction-oriented companies, there may be regulations that may hinder the concept. By encoding the transcripts, an attempt was made to give more meaning to the configurations and to discover the difference in customer type and regulation between the two configurations. Section 5.1 elaborates on configuration [I] and section 5.2 describes configuration [II] and the difference between configuration [I] and configuration [II].

5.1 Configuration [I]

Configuration [I] indicates that the (non-residential construction-oriented) companies that offer the product as a service have created solutions to the following barriers: pre-financing, supply chain, and customer acceptance. In addition, configuration [I] indicates that vertical integration and ICT systems conditions are also present at these companies. The following paragraphs provide more insight into the conditions.

Pre-financing

Twelve respondents indicated that the issue of pre-financing was a challenge. Six companies created a solution to this challenge. The coding of the transcripts (Appendix IV) indicates that equity was used in all cases for pre-financing. In two cases, pre-financing took place entirely in form of equity and in two cases a combination of equity and debt was used. Considering the two respondents whose companies were pre-financed completely with equity, it appears that these companies also had ownership of the product and that this product could be taken back from the building relatively easily. It emerged from the interviews that these were important conditions in the decision to finance with equity. In other words, respondents with 100% equity dared to make the investment because they could

use the product as a collateral. However, the two respondents whose companies financed with 100% equity did indicate that there was an enormous pressure on the cash flow, which would in the long run require debt capital to scale up the concept. In other words, despite the fact that in some cases financing could be provided from equity, products like service concepts in the construction industry did not escape the need for debt.

There is a difference between infrastructure and non-residential construction-oriented companies when it comes to attracting debt capital. Namely, all respondents whose companies are oriented towards non-residential construction indicated that banks did not easily provide debt for product as a service concept. Respondents whose companies had an infrastructure orientation indicated that although it was a challenge, some large Dutch banks were willing to finance it. This is probably because these respondents mainly have the government as their customer and the government may offer more payment security. There is also one respondent (representing an infrastructure-oriented company) who pointed to foreign companies, such as companies in America and Australia, that specialize in financing this type of concept. Finally, it emerged that groups of wealthy private individuals are prepared to make assets available for this type of concept, even though it is not always easy to get in touch with these types of investors.

In conclusion, pre-financing remains a challenge because, in the long term, there is no escaping from debt capital. Of the manufacturers that have succeeded in rolling out the product as a service concept, the non-residential construction-oriented manufacturers have pre-financed the concept from their capital, and the infra-oriented companies have managed to obtain their debt capital from major Dutch banks or from abroad. It is interesting that the respondents indicated that more and more Dutch banks were starting to finance this type of concept, but that it remained a challenge.

Customer acceptance

The second condition in the configuration concerns customer acceptance. What is striking is that (traditional) customers like contractors are less open to a product as a service concept because of the conflicting interests between them, the manufacturer, and the user. Six respondents pointed out that projects with a contractor are almost always built traditionally using a traditional payment model for the contractor. The contractor is often concerned with the cost of materials and the possibility of reducing that cost as much as possible. This is probably because the contractor usually earns his money from a margin on the purchase price at the start of the project. When the project is sold as a product as a service concept, the total investment is spread over several years so that the purchase price is lower, and the contractor consequently earns a lower percentage on the project. No solution for this has been created yet. In other words, the resistance from the contractor is a persistent obstacle.

It is therefore not surprising that the manufacturers that use the product as a service concept have customers who are different than contractors. For example, non-residential construction-oriented companies mainly refer to investors and property developers as the ideal customer type. This is because

investors who understand the concept realize that they have an up-to-date product and can pass on the costs they usually have to pay per month in the rent. Just like the developers (with their own portfolio), they also get an investment reduction, which means that they need less money in the beginning and can, therefore, use the capital in other areas. In conclusion, acceptance of the product as a service concept is dependent on the customer's earnings model

Supply chain

Considering the service-oriented group, it is striking that this group has a large part of the chain under its control. One respondent even mentions a percentage and says that 85% of the chain is within the concern. The remaining 15% is selectively supplemented with partners who support the concept. Another respondent also said: *"Some do not want to, they do not understand. Well, then you have to ask yourself whether that is the partner for the longer term"*. In order to make it attractive to the partner, the group guarantees its partners several orders per year. In other words, the group that experiences less resistance in the chain has a large percentage of the chain under its management and supplements the percentage through a selective choice in which the partners also have an advantage. A team is formed, as it were.

In the group that experiences resistance in the chain, attempts are also made to form such a team. However, they do not have a large percentage of the chain under their control, as a result of which the team consists of several companies with different interests. Four respondents mentioned conflicting interests that were related to different earning models of the partners. One respondent also indicated that the construction sector was not very transparent, which sometimes makes it difficult for parties to trust each other. Thus the group that experiences resistance in the chain has to work together with several partners who may have conflicting interests.

Vertical integration/IT-systems

As described in the previous paragraph, the service-oriented group has a large percentage of the chain under its control. As a result, fewer contracts need to be created with external partners, and there are fewer conflicting interests. They also have IT systems to collect data to support the concept. The group indicated that the data were not only used to improve the product but also as an argument to convince the customer and debt providers that the product as a service concept was more attractive than the traditional concept. In other words, the group with a service-oriented business model can paint a good picture of the concept because they have all the processes under their control and they also have the data at their disposal.

On the other hand, the group with a product-oriented BM often does not have insight into the data. One respondent indicated that they were collecting the data but that the data were encrypted in a system and could not be combined with the other data needed to paint a clear picture. Another respondent from the group said that the data were there, but that they provided information only about the production

process. Another respondent stated that they did not have any data, only certificates of reliability that could serve as a guarantee for the providers of debt capital. In other words, the group with a product-oriented BM appears less advanced regarding the collection and use of data than the group with a service-oriented BM.

5.2 Configuration [II]

Considering the difference between configuration [I] and configuration [II], it is noticeable that the configurations only differ concerning the conditions "customer acceptance" and "regulation." Concerning the creation of configuration [II], it is striking that this configuration is filled with input from infrastructure-oriented manufacturers. Thus there is probably a difference between infrastructure and non-residential construction oriented manufacturers concerning the conditions "customer acceptance" and "regulation." The next two paragraphs discuss these conditions.

Customer acceptance

Regarding the transcripts of the infrastructure-oriented manufacturers, it is striking that this group mainly does business with the government. All respondents mentioned that the government reacted reluctantly to a product as a service concept. They mentioned that although a distinction could be made between the provincial and local authorities, the general reaction was nevertheless one of aversion. Five respondents indicated that "the baskets" in the government were an essential obstacle to this reluctance. This means that the government's budget is fragmented, and it is challenging to combine fragmented budgets. To illustrate, the government may have a budget for construction (1,000) and a budget for maintenance (800). If the manufacturer can offer the product in a product as a service model and can, for example, save on maintenance, then the manufacturer could arrive at a cost allocation of 1,100 for construction and 300 for maintenance. The problem is that construction exceeds that budget, although there are savings in maintenance that would result in overall savings. Respondents indicated that in these situations, it was difficult to get money out of the maintenance budget, which ultimately resulted in the adoption of traditional, and in the long term, more expensive model.

In addition to the problem of fragmented budgets, seven respondents indicated that ownership of the product was an essential item for the government. The respondents gave two explanations for this. First, the government has a certain responsibility towards its citizens and is afraid to relinquish control when certain things are privatized. Secondly, three respondents indicated that the government had its own maintenance department. This means that when the manufacturer does the maintenance, the government gives up its own jobs, which leads to high resistance within the government organization. All respondents indicated that because of the government's circular vision, the government was in the process of change, although it was proceeding in small steps. In other words, the government is not yet entirely open for a product as a service concept.

Regulations

There is a difference regarding the condition “regulations” between configuration [I] and configuration [II]. Knowing that configuration [II] is formed by infrastructure-oriented companies and has no regulatory barriers, it would appear that companies that focus on non-residential construction may experience regulatory barriers. Reviewing the coding scheme (Appendix IV), it is striking that two laws stand in the way of the product as a service concept. The first relates to the property ownership structure. Three respondents indicated that the ownership structure was a problem because when a product is installed on a building, it is seen as integral part of the building and thus automatically belongs to the owner of the property. However, two respondents said that this could sometimes be solved through surface right, a right of way, or, in exceptional situations, a rental construction. However, it should be noted that these constructions are not suitable for all products. Secondly, two respondents mentioned that building regulations may stand in the way of a the product as a service concept. The discussions with these two respondents revealed that it was mainly the uncertainty about the buildings code that was the barrier. To illustrate, the building code states that a window frame must be at least 1 meter by 1 meter, while this may be different in 30 years. However, another respondent refuted this and said that there was little chance that you would be judged in the future on legislation that applied in the past and that the building code would not change quickly (with the exception of elements that have an impact on the environment). To summarize, for the group that concentrates on non-residential construction, the regulations relating to the ownership relationship are a possible barrier, but in some situations, this can be overcome by surface rights, the right of way, or rental constructions.

5.3 Necessary conditions

The previous paragraphs have revealed that there are two configurations required to shift to a service-oriented BM. The only remaining difference is that it is not yet clear whether one of the conditions is necessary. The NCA has provided insight into these conditions. Table 13 below presents the results from the NCA.

Table 13 Necessary conditions

Conditions	Consistency	Coverage
BarrierPre-financing	1	0,67
BarrierSupplychain	1	0,8
BarrierCustomerAcceptance	0,5	0,4
BarrierRegulations	0,75	0,5
StimulatorVerticalIntegration	1	0,57
StimulatorICTsystems	1	0,57

Table 13 indicates that the conditions of pre-financing, supply chain, vertical integration, and ICT systems are necessary for the service-oriented group (Consistency 1). As described in the previous paragraphs, respondents from the service-oriented group use their data to convince debt providers of the attractiveness of the service concept. This was not the case with the product-oriented group. This may be supported by the consistency of 1 for the conditions "pre-financing" and "ICT systems," which indicates that these conditions are fully present in the service-oriented group. It is also noticeable that the service-oriented group has almost the entire process under its own control (vertical integration), while this is not the case with the product-oriented group. The last condition that is consistently present in the service-oriented group is the condition "supply chain." This indicates that the service-oriented group experiences virtually no resistance from the chain. This can probably be explained by the fact that they control a considerable part of the chain. Thus, there are four necessary conditions that companies need to have in order to shift to the service-oriented BM:

- Solution for pre-financing;
- No resistance in the chain;
- Major part of the chain under own control;
- Data to support the concept.

The next section will combine the results of this research with the theory as described in the literature review.

6. Discussion & conclusion

As described in the "problem definition" section, it appears that it is not clear how the transformation from product-oriented BM to service-oriented BM can be made and which factors influence the transformation positively or negatively. This research aimed to explore the configurations of inhibiting and stimulating factors in the transformation process from a product-oriented to a service-oriented BM. To give more direction to this aim, the research question below has been formulated:

“What are the configurations of inhibiting and stimulating factors for construction manufactures in their transformation from a product-oriented to a service-oriented business model in the Netherlands?”

The results indicate that there are two configurations associated with a service-oriented BM. The configurations are almost identical but differ regarding customer acceptance. The results also indicate that a solution for pre-financing, removing resistance in the chain, vertical integration, and data collection are necessary conditions for transforming a BM from a product-oriented to a service-oriented one. Additionally, there is a synergy between these necessary conditions. The resistance in the chain is

somewhat reduced when a large percentage of the supply chain is under a company's control. These disciplines collect their data, which are bundled to get a total overview of the service concept. These data are used to support the raising of debt capital. In other words, vertical integration and data collection act as necessary stimulating factors to eliminate possible inhibiting factors such as pre-financing or resistance in the chain.

Returning to the literature review, according to Vermunt et al., (2019), there is a higher degree of dependence on external partners when creating PSS construction models, which creates conflicts of interest. This could be solved by vertical integration, thus involving fewer different partners. According to Baines and Lightfoot (2013), vertical integration is also one of the stimulating factors. However, few organizations can carry out the whole concept alone (Baines et al., 2007). It would be interesting to do follow-up research into this. The need to collect and use data as a stimulating factor corresponds with Coreynen et al.'s study (2020), which indicates that the obtained data can be used not only for the exploitation and exploration of the concept but also as a support for attracting debt capital. In other words, vertical integration can lead to less resistance in the chain, and bundling the data from different disciplines can also serve as support for attracting debt capital.

Another remarkable result of this study was also the difference in customer acceptance. According to Vermunt et al. (2019), there is little customer and stakeholder acceptance for the PSS concept. In theory, it is assumed that this acceptance is mainly absent because the stakeholders do not understand the total costs of ownership or use (Tan, 2018). According to Gustafsson et al., (2005), this depends on which layer of the organization the customer contact takes place in. It is also assumed that the PSS concept is often too complex, as a result of which customers do not accept it (Mont, 2002). The results of this study seem to indicate that there are different customer segments within the construction sector, each with its own degree of acceptance. Complexity is one of the reasons why some customer segments do not readily accept the concept. These results are therefore in line with Mont (2002). For those customer segments that demonstrate less acceptance for a PSS construction, the fundamental difference in earning models is an obstacle, since they would have to adapt their earnings model to fit a PSS structure. In other words, customers are divided in terms of acceptance of the PSS concept. Important factors are the complexity of the concept for the customer and the customer's revenue model.

6.1 Theoretical implications

The literature extensively mentions the barriers that occur during the process of servitization, but little attention is paid to the development of tools to solve these barriers (Baines et al., 2009). In this study, a synergy between the barriers and stimulant factors has been created by investigating the configurations of inhibitory and stimulant factors. This study has demonstrated that the use of data can offer solutions to barriers in relation to pre-financing, and vertical integration can be used to solve conflicting interests in the chain. In other words, the use of data and the application of vertical integration

can be used as ingredients in the tools to be developed. From a theoretical perspective, this has also contributed to more clarity on the design side of product-service systems (Mont, 2002).

Besides, the empirical data from this study complements the generalizability of the barriers related to servitization. Vermunt et al. (2019), asks for more empirical data to verify whether the barriers mentioned by them can be generalized to a certain extent. This study explores barriers in the construction industry. Based on the results of this study, it can be argued that the barriers; there is no market acceptance, there is resistance in the chain, and barriers relating to pre-financing are also hindering the transformation in the construction industry. However, some claims such as regulation hinder the transformation (Vermunt et al., 2019) are not determined effectively in the construction industry. For example, while the product-oriented group seemed to agree with this claim, the service-oriented group clearly disagreed by indicating that creative solutions have been found. In other words, though this research supports Vermunt et al. (2019), that factors such as customer acceptance, supply chain, and pre-financing can be inhibiting factors in servitization, but not all factors have been confirmed. More research is needed to confirm the possible barriers and the solutions for the process of servitization.

6.2 Practical implications

This study delivers essential ingredients to develop tools for managers trying to achieve servitization. From a practical perspective, the problem description revealed that managers and directors lack the know-how on how to transform from a product oriented- to a service-oriented BM. Depending on the degree of knowledge regarding servitization of managers and directors, this research has its added value. For the group that argues that regulation with regard to ownership is an obstacle, several possible solutions are suggested that might give them new insights. For example, surface right, a right of way, or, in exceptional situations, through a rental construction.

For the group that doubts whether the customer is open to the concept, the suggestion is given to think about how their customer revenue model is composed. In the construction industry, it appears that governments and contractors are relatively less open to the concept than project developers with their portfolios. It is, therefore, also conceivable that if companies in the construction industry wish to servitise, they will have to shift more towards customer segments such as project developers. If the companies stay with the current target audiences than they have to accept the resistance from customer segments such as contractors and the government. In the latter case, there are signs that the government is trying to move along, but it should be taken into account that there is an increased chance that a tender will ultimately end up with the traditional model.

For the group that experiences resistance in the chain, an option is given to apply a certain degree of vertical integration. Not all companies can fully integrate vertically. However, vertical integration is not the end, but the way. The real problem is the conflicts of interest between the different partners. The more partners there are connected, the more interests there are. Therefore, if companies cannot apply

vertical integration, they will have to seek other ways to reduce conflicts of interest. Unfortunately, it is not yet clear how these conflicts of interest can be reduced. Perhaps companies can guarantee the partner a certain amount of work in one year, but it is questionable whether this is sufficient.

Finally, it turned out that data has an important role to fulfill in the concept. The data can be used in the exploration and exploitation phase. This research also demonstrated that the data is used to convince customers and debt providers that a service concept is more attractive than a traditional model. It is important to combine different data streams with each other. This is a challenge because a lot of data is encrypted in a specific system. In other words, the correct use of data can solve problems in pre-financing and customer acceptance.

6.3 Limitations and future research

By integrating the results of the systematic literature review, the configurations, the necessary conditions, and the coding, a deeper understanding of the inhibiting and stimulating factors has been gained. This research suggests that vertical integration leads to less resistance in the chain and has a positive effect on the transformation. However, few companies will be able to achieve full vertical integration. An interesting follow-up study could investigate to what extent should there be vertical integration.

However, there is a limitation to this question in this research. This research made use of csQCA, as a result of which there was a hard threshold between whether or not there is vertical integration. Further research could make this line more accurate by using fsQCA and calibrating the condition, for example, 20%, 30% of the processes under its control. Also, because of complexity, not all variables from the literature review are included in the conceptual model. As described in the section "conceptual model", further research is needed that approaches the results of this study in an epistemological perspective and adds the other variables from the literature review. In other words, this research had a certain lack of calibration to achieve more accurate results, and not all barriers identified in the literature have been included in the analysis.

It can also be questioned to what extent the model is robust for code changes. In this study, there are only four companies that have actually completed DBFM(O) contracts and have, therefore, been categorized as service-oriented companies. If codes within this small group are misinterpreted, this can lead to different results and compromise the robustness of the model. It will therefore be interesting that follow-up research can include more service-oriented companies in the sample in order to increase the robustness of the model.

Although 13 respondents and two informants, all from the construction industry, were interviewed in this study, more empirical data are needed to support the suggestions from this study. It should be noted that the respondents were interviewed only once. Although the 13 respondents held positions for which knowledge of the company is required, it is possible that not everything was said

during an interview. Thus, not only would multiple measurements over time be an interesting addition but so would also the use of multiple measurement to increase the internal validity.

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“If you want to go fast, go alone. If you want to go far, go together!”

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Appendix I (Template interview)

1. Introduction

This research focuses on the transformation from a product-oriented to a service-oriented business model in the construction industry. A concrete example of such a transformation concerns the elevators of Mitsubishi. These elevators were first offered on a transaction basis, but nowadays also on a service basis. This means that an x amount is paid to Mitsubishi each month and in return, the lift is installed, and Mitsubishi ensures that the lift continues to work.

With this research, I'm trying to find out what the inhibiting and stimulating factors are that influence the transformation process from a product-oriented to a service-oriented business model. Part of the research is an interview. In this interview 8 variables are measured. The goal is to eventually get an answer like "yes" or "no" for each variable. The answers to the variables are then processed in an analysis tool. In this tool, the results of the 8 variables are compared between the 16 companies participating in this survey. For others than my supervisors and myself, it is not possible to link the individual answers to the interviewed companies. In other words, your given answers are processed anonymously.

General

1. Do you have any questions about the study you are about to participate in? (If so, you can ask the questions during the interview)

Screenener question

If yes to the four questions below, could you explain?

3.1 Is there a similar construction within (company name) as the example of Mitsubishi?

3.2 Are you involved in the evaluation and/or change of your business model?

3.3 Do you offer a product that generates revenue through use?

3.4 Do you offer a product with a rent/lease agreement?

3.5 Do you offer products/projects where you also provide maintenance for a duration of 5-15 years?

Financial Obstacles

(1) Pre-financing

1. If you go to a service-oriented model with lease constructions, do you have sufficient equity to pre-finance the products or do you need loan capital?
2. If you need borrowed capital or want to use borrowed capital, do you find it easy to do so or do you experience resistance from the providers of borrowed capital?

Control question

3. Have you already been in contact with debt capital providers regarding the concept of 'product as a service'?

Conclusion question

4. So, if you are going to offer the products more as a service, is pre-financing a problem for you? (yes, no)

Barriers External environment

(2) Supply chain

1. Who do you have to deal with before you can offer the concept as a service?
2. Are these parties open to a product as a service concept?
3. Why are these parties open for a product as a service concept?

Conclusion question

4. Do you experience resistance within the chain with regard to offering a product as a service?
(Yes, no)

(3) Customer acceptance

1. Who are mainly your customers?
2. Do customers see the added value of a service construction?
3. Do you think the customer still attaches a lot of value to ownership of the product?
4. The concept of "total cost of ownership" means that not only short-term, but also long-term costs are taken into account. Do you notice that the customer thinks in terms of total cost of ownership?

Conclusion question

5. Are your customers interested in purchasing the service construction?
(Yes, no)

(4) Regulations

1. During the preparation or execution of the service construction, did you encounter regulations that do not support or counteract the concept?
2. Have you been able to solve this?
3. How did you solve this?

Conclusion question

4. Can I conclude from this that regulation does/does not hinder you towards a service-oriented business model?
(yes, no)

(5) Vertical integration

1. Do you have a separate discipline that focuses on the service part only? (If so, could you explain this a little?)
2. Does this discipline work in teams with different backgrounds?
3. If a separate service discipline has a separate B.V. to spread the risks?

Conclusion question

4. The discipline of design, construction and maintenance are you in-house and strictly separated from each other?
(yes, no)

(6) IT systems

1. Do you have IT systems available that store information during production, installation and maintenance?
2. Do you have the right IT to control or monitor the maintenance remotely?
(Think of the printers where you can remotely see if the cartridges are empty)
3. How many years have you had these systems?

Conclusion question

4. There is technology available that provides insight into the results of the product as a service concept.
(yes, no)

Appendix II (Dichotomous table)

Dichotomous table

CaseID	Stage	BarrierPrefinancing	BarrierSupplychain	Barriercustomeracceptance	Barrierregulations	StimulatorVerticalIntegration	StimulatorICTsystemen
Case1	1	1	1	1	1	1	1
Case2	1	1	1	1	0	1	1
Case3	1	1	1	1	0	1	1
Case4	1	1	1	1	1	0	1
Case5	0	1	0	1	1	1	1
Case6	0	1	1	1	0	1	1
Case7	0	0	0	0	0	0	1
Case8	0	0	0	0	0	1	0
Case9	0	0	0	1	0	0	0
Case10	0	0	0	1	0	0	0
Case11	0	0	0	0	0	0	0
Case12	0	0	0	0	0	0	0
Case13	0	0	0	0	0	0	0

Truth table

BarrierPrefinancing	BarrierSupplychain	Barriercustomeracceptance	Barrierregulations	StimulatorVerticalIntegration	StimulatorICTsystemen	number	Stage	raw consist.	PRI consist.	SYM consist.
0	0	0	0	0	0	0	3	0	0	0
1	1	1	0	1	1	1	3	1	0.666667	0.666667
0	0	1	0	0	0	0	2	0	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	0	0	0	1	1	1	0	0	0
1	1	1	1	0	1	1	1	1	1	1
1	0	1	1	1	1	1	1	0	0	0
1	1	1	1	1	1	1	1	1	1	1

Appendix III (QCA results)

Model: Stage = f(BarrierPrefinancing, BarrierSupplychain, Barriercustomeracceptance, Barrierregulations, StimulatorVerticalIntegration, StimulatorICTsystemen)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.666667

	raw coverage	unique coverage	consistency
BarrierPrefinancing*BarrierSupplychain*Barriercustomeracceptance*StimulatorVerticalIntegration*StimulatorICTsystemen	0.5	0.25	1
BarrierPrefinancing*BarrierSupplychain*Barrierregulations*StimulatorVerticalIntegration*StimulatorICTsystemen	0.75	0.5	0.75
solution coverage: 1			
solution consistency: 0.8			

Model: Stage = f(BarrierPrefinancing, BarrierSupplychain, Barriercustomeracceptance, Barrierregulations, StimulatorVerticalIntegration, StimulatorICTsystemen)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.666667
Assumptions:

	raw coverage	unique coverage	consistency
BarrierPrefinancing*BarrierSupplychain*Barriercustomeracceptance*StimulatorVerticalIntegration*StimulatorICTsystemen	0.5	0.25	1
BarrierPrefinancing*BarrierSupplychain*Barrierregulations*StimulatorVerticalIntegration*StimulatorICTsystemen	0.75	0.5	0.75
solution coverage: 1			
solution consistency: 0.8			

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.666667

	raw coverage	unique coverage	consistency
BarrierSupplychain	1	1	0.8
solution coverage: 1			
solution consistency: 0.8			

Appendix IV (Coding Scheme)

Stage	CaseID	Message	Open	Axial	Selective	Target segment
service oriented	Case1	Well, it's about the investor who buys. A building in which at least in function is an elevator that is always up to date. And that investor once he understands the model there. He sees that he can pass on 100 percent of the costs of use to his end users in the service costs. And then that user is no more expensive than usual. As soon as you know that, that investor will also be the backbone buyer, because then you won't have to pay for major replacements. During the lifetime of the building, you can write more on the elevators, so that's the profit for the investor. For the end user it's just they know where they stand. And they know that they are guaranteed to always have a good function. You have no detentions, you have no hassle and you have no nuisance.	up-to-date	Investor	Customer acceptance	Investor
service oriented	Case1	If you look at the client type a traditional contractor. That contractor is not so much interested in investing in such a thing in the traditional sense. Because the moment you lift at the front at zero euro in a building, you realize his return on the purchase of a product. Yes, then you can have a 10 percent return. But if your purchase is 0 euros then you do not have much, so for the contractor it is the most exciting. Then you have a developer. A developer who thinks it's fantastic, of course, because his realization sun of a building will be reduced by the sum for the elevators. That might have been a million and not zero, so you've got a million to go.	traditional revenue model	Contractor	Customer acceptance	Contractor
service oriented	Case4	you see that developers are obviously much more driven. From a financial point of view that are going to calculate, I keep this ten 15 years your portfolio. So after that I'm going to put it back on the market and sell it and make a profit on the transaction and that corporation that thinks in the long term 50 60 years that has low maintenance costs is a big difference.	Investment reduction	Developer	Customer acceptance	Developer
service oriented	Case1	Both some don't want to, they don't get it. Well, then you have to wonder if that's the long-term partner	Connection	selective choice	Partnerships	

product oriented	Case5	Yes, what his party, that is to our suppliers, say and in that case, they still find it difficult, hear them say right away: we do, we participate or we understand, and we're going to do it again, are already quite hesitant. Yes, but that's also because we have the contracts and enter into contracts with customers and they supply us with a semi-manufactured product which we then make into a total product ehm. I think that either yes, or of course you can refer to our customer that he is beginning to understand.	No collaboration	conflicting interests	Partnerships
product oriented	Case2	That's different for each partner. Because you have partners who think with... I do want a partnership, because that gives me a certain guarantee and work. We are also suppliers or subcontractors who say no, I don't want to commit to you.	Connection	guarantee of employment	Partnerships
product oriented	Case7	Yes, what I found very funny for myself, actually to see is that we very quickly talk about integrality, at BINX we already build installation integrally, so you just tuning really makes a profit to include maintenance, once broad look, but you see that you are so dependent on everything that happens at the front. So when you talk about integrality that time that integral, that time really starts, almost at the moment that there is already a thought for something new and not so much the integral time about everything that is construction related, but also what is design related and what is agreement related is legally related is that integral time that should just become much broader and much better. Those are all still islands.	Conflicting interests	Islands	Partnerships
product oriented	Case7	No, of course they have their own earning model in this whole column and that way they just fly the project that is on.	Conflicting interests	Islands	Partnerships
product oriented	Case6	We as ... normally for Dutch one we can take anything, so inspections, but when determining whether certain carry out in that. We actually have a total package	Connection	Personal management	Partnerships

product oriented	Case11	Well, very simple: do you know the price, the cost price of a house or what you have to pay for a house. Nowhere on the internet is it very shady what something costs, for example, or yields, but also how something works. For example, everyone does everything in their own way. You have a lot to deal with a lot of parties that are part of the whole huh, a constructor architects all kinds of suppliers, ehm the municipality, the province and surroundings. Yes yes, at some point. Does it drive you crazy?	suspicion	vague	Partnerships
service oriented	Case4	Yeah, but of course we are. Look, we do have 85 percent of ... Then you have to think of the concrete factory, the concrete production, even the factory, the carpentry factory, the bathroom factory. The installations are entirely under our own management. What you don't own is, for example, the kitchen. We buy that.	Connection	Personal management	Partnerships
service oriented	Case1	We hebben in de basis hebben we t zo gedaan dat wij hebben gezegd we willen de investering aan de voorkant naar nul reduceren en op basis daarvan heb ik eigendomsrecht nodig, want ik wil onderpand houden op datgene wat ik als financiering wegzet. En op basis daarvan ontkom je niet aan een soort van lease constructie. Maar dat is alleen maar om die financierings kant aan de voorkant, onderpand behoeften in te kunnen vullen.	pledge		pre-financing
service oriented	Case1	Yes, we started with equity because loan capital was not available. No bank wanted to go. It was seen as a lease construction and that had the next say custom jacket for the average bank. Then it could be five to seven years. In period it's not allowed. It may not be project specific and may not be attached to the building. It must be easy to take away. We did not meet any of those conditions, because we had at least twenty years. Where were nail stuck and project specific. So no bank wanted to participate in principle. Then we started on equity, but we became incredibly successful and at some point you get some pressure on your cash flow. Luckily, a bank has now hooked up. We also concluded a contract with it. In principle, it has reserved 100 million to finance us. But there are also other banks that are now preparing to join us.	equity capital		pre-financing

product oriented	Case5	So would we do it at the last minute? The bank withdrew. They said we wouldn't, because they thought what I just said was too exciting, but we'd already developed everything. We'd developed the contract, the system, everything you have to tackle to do something like that	uncertainty	success factor	pre-financing
product oriented	#N/B	so you see more and more clubs, clubs, people who then spread the risks, and then with zn, four or five and and yes invest in the building, say ma	parties	horizontal integration	pre-financing
product oriented	Case11	It's a very good question what you're asking. Look, we make money making window frames and element. Well, we're dealing with a limited, limited amount of resources like everyone else has. You have a limited amount of money and resources. And that's where you have to make your money. So from that one euro. What you have, you have to make two. Well, then, how can I make two out of one euro? I can do that by putting more effort into selling the current earning models than by stopping that euro. In the rigging of product is service of which the factor. The guarantee of success is a lot smaller.	uncertainty	success factor	pre-financing
service oriented	Case3	This must always be done in combination with investors. Then you can't end up	combination of equity capital/debt		pre-financing
product oriented	Case7	Yeah, and it's also the question that's not there yet, so it's in the interest of not funding things that way yet	No demand	success factor	pre-financing
product oriented	Case7	The projects we do are not the smallest projects, which means that you have to take a lot of resources with you if you want to do the finance part in the first place. And well, that in itself is a challenge for a company that has been around for just over five six years. So that part from the bank and that part of its financing and yes, you don't just get around to it.	No equity capital		pre-financing
service oriented	Case4	Well, I guess so, look... is, of course, a huge concern. We've had the good fortune that former director owner... had the idea of. I want a one a one factory solution for homes and I guarantee the first 1000 homes. He personally guaranteed ehm	equity capital		pre-financing

service oriented	Case1	If you look at the client type a traditional Contractor. That Contractor is not so much interested in investing in such a thing in the traditional sense. After all, at a moment when you're hitchhiking at the front of a building for zero euros, you're actually making a profit on purchasing a product. Yes, then you can have a 10 percent return. But if your purchase is 0 euros then you don't have much, so for the Contractor it is the most exciting thing.	return on purchase	Contractor	customer acceptance	
service oriented	Case2	Yeah, I might as well. Personally, I think it might depend more on the type of client. Think the culture at our governments is that everything they have and are in control must also be owned. That also has more to do with the responsibility they have for that piece of road, for example in this situation.	image society	government	Customer acceptance	Government
service oriented	Case2	The more parties they have to manage to carry out the maintenance. The more complicated it becomes for the client. The client generally outsources maintenance to one party and that party does the mowing work. And that party empties the bins. He does the maintenance and markings and so on. And so he always has a single point of contact for his entire arial of the entire area.	1 main contractor	government	Customer acceptance	Government
service oriented	Case2	Our clients are generally governments. We see that they are not yet eager for a service-oriented product and prefer to simply purchase and manage it themselves.	reluctance	government	Customer acceptance	Government
service oriented	Case1	Yes, we have a Dutch major bank. And by now, the other Dutch major banks, but also Belgian banks, are very keen to join. But that's still a fight. That really is a challenge. And that is also stretching of possibilities	debt providers		pre-financing	
service oriented	Case2	Their business is, of course, investing and investing in order to get even more money in the end. And you'll only experience resistance if they see risks they can't control or if they think they can't get enough return out of them.	debt providers		pre-financing	
service oriented	Case2	Yes, because these are specialized investors who invest in this kind of projects. They also have experience with infrastructural projects. They know the risks and they know better how to manage those kinds of risks themselves. They are generally large foreign investors, not generally Dutch investors either. Australia has a very large one. America has a gro	foreign debt provider		pre-financing	

product oriented	Case6	the period that, at the time of a lecture or an incident, will indeed be a maximum of four years and then after four years the cards will be fired again.	shift	government	customer acceptance	Government
product oriented	Case7	The Contractorij has been forced in that direction from a history, simply by the form of contracts.	distress forced	Contractor	customer acceptance	Contractor
product oriented	Case7	That's just 15 percent cheaper to outsource it in that way than just traditional, but those Contractors, who find it very difficult to take that risk of responsibility in that as well. And that's why you often see that it just doesn't happen anymore and that the Contractor doesn't want to get the contracts to rebuild and operate it in that way anymore.	risks	Contractor	customer acceptance	Contractor
product oriented	Case7	So you have to work together at the front in a different way and the traditional tenders that are very much focused on their main Contractor and that main Contractor is often only a builder who delivers a product which makes it very difficult to look at your building in a different way than just as a product and that is also a bit of the challenge that we face	Conflicting interests	Contractor	customer acceptance	Contractor
service oriented	Case1	Governments are troublesome because they have less freedom to do things in such a lease construction. They are very much owned. That's where they are now, so to speak, based on their number of frameworks and structures in their tender regulations. For governments, of course, it is also very exciting, because the moment when you put such a thing out to tender is very exciting. There is only one that can offer it in the market. Then you have little competition game.	tendering rules	government	customer acceptance	Government
service oriented	Case1	Well, it's about the investor who buys. A building in which at least in function is an elevator that is always up to date. And that investor once he understands the model there. He sees that he can pass on 100 percent of the costs of ...use in the service costs to his end users.	up-to-date	Investor	customer acceptance	Investor
service oriented	Case1	Then you have a Developer. A Developer who finds it fantastic of course, because his realization sun of a building will be reduced with the sum for the ... That may have been a million and not zero, so you've got a million to catch	Investment reduction	Developer	customer acceptance	Developer

product oriented	Case8	the Contractor with a Contractor you notice a lot more, they are much more on the things of what costs a square meter. And how can I buy that as cheaply as possible?	traditional revenue model	Contractor	customer acceptance	Contractor
product oriented	Case3	so that's definitely one thing. A number of them will of course have to make cuts. But if you look at the civil service, yes in general, then of course they want to keep their jobs. You do see changes and a number of a client if they try to outsource that. You've put that down to the contractor, and then to the provinces of Rijkswaterstaat and the larger municipalities, which of course also dared to put a piece of road down.	job retention	government	customer acceptance	Government
product oriented	Case3	And it all works internally. The municipalities also do not work together, so the moment a project is applied for or not involved with the mutual club, it means that a budget for 1000000 is released, for example for a new project to be built. But that would be possible over the course of the project, if you put that in your maintenance. But in the first instance you would have to pay more, and of course they still find that scary, because that would mean that for that project in 2000000 would be lost. And in ten years' time, too, that will certainly be cheaper if you get maintenance with that. But there will be a lot of that. So in the beginning we don't want to pay too much, so that's where it all goes wrong.	budgets	government	customer acceptance	Government
product oriented	Case6	So actually, you're very dependent on who's in government. What his knowledge in that area is and how fanatical he is, say if you hurry it up, so to speak, and he doesn't want to immerse himself in it. Yes, that's when something else comes out of it that is actually good in the long term.	shift	government	customer acceptance	Government
product oriented	Case6	yeah, especially an investor, but you have to keep it on your own turf.	Personal management	Investor	customer acceptance	Investor
product oriented	Case6	A civil servant on its own, they, but that zero even longer, then you look at all a civil servant who sits for a long period of time. Only the drivers are always there for the period of time and if you want to ask the driver now of hey, if you save something now, we now make a choice with zn, say save an hour which can benefit in the longer term then it becomes the short term.	short term	government	customer acceptance	Government

product oriented	#N/B	That yes, yes, no, that's actually a bit there is a indeed a substantial difference in the Contractor that bolt and that calculates hours and materials actually and materials, and that does not intend to keep the building. Just say the one who developed those legs, but don't say not to keep them yourself. And the developer, who will do that more often or for his own portfolio, say or for a third party to realize a building. Say it or build it? And and resell it, so to speak, and the Contractor is really just the hands on the construction site, so to speak. In this case, I also think that you shouldn't be with the Contractor, but the developer, say, who then hires the Contractor and then tells the Contractor. What he should do	traditional revenue model	Contractor	customer acceptance	Contractor
product oriented	Case12	yeah, that's the construction is also very cyclical is the moment is now in a few good years. Well you. We corona later and I can change again very quickly. So yes, at times it's very short term. It really is. I survive, I read that and then we all know that tomorrow is more important than next year, but what good is next year if you're not there tomorrow?	conjuctural sensitivity	short term	customer acceptance	
product oriented	Case11	Yeah, that's a big deal, because you have to be willing, of course, but at some point at risk. For the project it is best to have a Contractor that runs. Lots of risks, huh. They make building dr. Risks on and at a certain point in time, of course, that's also transferring and being rid of them. Of course you don't want to stay, that's not their earning model. Their earnings model is to make something and not to keep everything under control. So that's, that's a completely different division of roles. Can't wait right now	traditional revenue model	Contractor	customer acceptance	Contractor
product oriented	Case11	That's a pretty tough question you're asking. They work very much from a total cost of ownership perspective, but I don't think that's really always decisive.	price	government	customer acceptance	Government
product oriented	Case8	And those investors and projectdeveloper, they just want a good product and all that and they don't want any nagging at all. They just want it now, if it costs me 500 euros a month. I'll charge that back to rent or whoever on whatever. But some of you just want that elevator to keep working. That it keeps going up and down, so to speak.	passing on	Developer	customer acceptance	Developer

product oriented	Case5	Those guys that say, yeah, yeah, um, an investor so that the money is in real estate, that feels right at the moment that one that real estate. Not that that the value is dropping, or that there is something, that it is not flexible enough that they can not easily change functions or allow a new tenant who, that is our target group. Yeah, so... Investors is.	up-to-date	Investor	customer acceptance	Belegger
product oriented	Case5	Even though I now see more and more that Contractors are hiring people with a circular title, so either a sustainability manager or a circular developer as a circular building specialist who will take care of that part and try to implement it completely. By developing within that Contractor	change BM	Contractor	customer acceptance	Contractor
product oriented	Case5	What you see is of course that which they say, but why would it or not be interesting for government-related companies, so a university, a school, the municipality building or a government building ehm, they find it very exciting and for them is usually actually no go who want nothing at all to do with is a service and while they do find circularly very important. So they prefer to buy a circular product. But then I say: yes, fine, I'll deliver a facade that is very easy to take out. And that's not going to happen for another 30 years. But who and where has ensured that this will happen then?	long term uncertainty	government	customer acceptance	Government
product oriented	Case5	Ah, corporations and so on just have a whole maintenance device and that's very expensive. Is it all fte fulltime we can do a little yes of everything? You're going to do that so inefficiently. If you ask the rope on, they fall so hard. They can't put very much back. Wouldn't we be doing any smart maintenance at all? And if you put that back with the producer and give them responsibility for a long time, do you? Becomes efficient and cheap, but then you have to throw those people out. Yes, and then you have with work and ethical and social where we bla	job retention	government	customer acceptance	Government
product oriented	#N/B	Yeah, that. That's a point and they don't want to get stuck. They also want to be able to operate more flexibly, so if you say I'm going to get a contract to naja well if you do it through the tender.	flexible	government	customer acceptance	Government

service oriented	Case2	Yeah, we've only been storing data properly for a couple of years. So yes, the data from Bruges that were built in 1960. That's really not complete. But we do know that if a bridge was built in 1960, and what its condition is at the moment and how it has held up. At which loads based on historical data determine how such a bridge keeps itself or how a roundabout keeps itself or how a road keeps itself. In addition to constructing roads, we also do road maintenance. So we really do know the costs involved in keeping a road in good condition.	clear data	argumentation	ICT-system
service oriented	Case1	Yes, of course we have. We look at the amount of use of the installation and we can estimate what say in the longer term in the wear process based on use at the elevators. Costs are going to come. Of course, we have a look through of these types of elevators, because we have already put several tens of thousands of them around the world. Since the end of 2002 and so we know very well what a basic product does. And we know from the Asian world in particular the higher use. Intensity is what it's going to do in millions of rides in the long run. And we can easily translate that to the Dutch environment, because that's where we get a lot of projects, not that high intensity of use and therefore not the maximum number of trips we can already calculate	clear data	argumentation	ICT-system
service oriented	Case1	And we need that again, because we need that to sharpen and lower the exploitation model even further. And that way you can avoid your financing burden, regardless of whether you charge interest for it. But then you can bring your financing burden to the back of your operating costs, but still not be more expensive than today's traditional costs.	clear data	product improvement	ICT-system
product oriented	Case7	Yes, but, those dates that are present, we, have about one and a half G's of data per day that we get out of the building, so that's really growing every day. As far as the performance is concerned, that data is very insightful for us, but I can't sell that data, because it doesn't say anything at all. It must be possible to provide much more context in order to ultimately have real insight into additional revenue models or whatever.	clear data	bland	ICT-system

product oriented	Case6	And we have our own equipment and we have our own laboratory. So say, if there's a council saying, well, we've got an acreage, we need inspections, so you've got you to make. So you can analyze in a lab you know that great level I what's in there. You've got equipment to measure the roughness, you've got to rest life and so if an x number of years lies	clear data	argumentation	ICT-system
service oriented	Case3	Yeah, yeah, yeah, we're working on that. Especially on some larger projects viaducts and locks. We have placed them together late in the day and they can then cope with how often their doors and lock gates are left over, for example whether the bridge deck goes up and down and don't know how many car seats they bring. Then we can all measure and with that we can predict maintenance, but it's still difficult to see what we're going to do in the future so yes, because of course you have to deal with these things in the underground. That can also cause a movement, so predicting maintenance. That's just a very tricky one. Measuring transporters movement and how often such a thing publicizes that, we can do that. There's no problem there.	clear data	product improvement	ICT-system
product oriented	Case11	We don't have one and we do, but of course he gives a guarantee and we are obliged to give a guarantee. We cobo certificates and stuff like that. We know for sure that our products are good, but we can't. We don't have a database of lifetime data and that sort of thing	data not clear	warranty	ICT-system
product oriented	Case12	The technique that technique is, there is only that technique that uses much more, but pre-defined maintenance planning in other words, products can be, but that maintenance cycle is then already a chip. The status of one of a door, for example having it measured by a chip, becomes a lot more difficult. I think, because you'll have to determine that thing so you'll be confused to what we've been dealing with that door, so to speak. There's a certain layer of paint on it, and it needs four more years to be painted or six your years. Then you decide. And if that chip helps you do your maintenance planning.	clear data	production process	ICT-system

product oriented	Case5	have a platform söderling are, have we co-developed? Don't we own a platform we developed with? That's also from the VNG. The branch organisation owns one third of the platform. We will keep track of that, a platform or a link with our software, Bim, software and production. Software, so that's where all the data is, can we link to it and retrieve it via one? Can you QR code that we stick on the window frames on a facade, which can be scanned with a smartphone or an iPad? Anything from there we can see all the information. But we can also, for example, record maintenance operations, let's do maintenance then record that, so actually give it a kind of logbook.	clear data	ICT-system
service oriented	Case2	Because you are bound by procurement rules and a moment you want to put a work back on the market? Then you will have to do so for our tender rules. So then you actually have to give everyone who meets your selection criteria the chance to apply again and take the work off your hands. That was the ideal situation for us if we could say to Rijkswaterstaat that you should always be at VolkerWessels. Because then you have a single point of contact. Maybe they want to, but they're not allowed to.	tendering rules	regulations
service oriented	Case1	What we do is that with an elevator shaft we get over the inside contours of the elevator shaft, where you have the right of building or in case of special situations leasehold and in the very last situation I get possible with tenancy law construction. If we look at the special circumstances of an existing owners' association. But what we basically do is get the property rights over the elevator shaft and with that I can be nice or if the product hangs in the building, but it remains ours.	ownership ratio	lease regulations
service oriented	Case4	It ensures that no scaffolding is needed. You saw a lot of comfort in that house, so it's important. A staircase is subject to the Buildings Decree, the Buildings Decree. That changes from time to time, because we get taller as people, for example. You used to have low ceilings. Nowadays you have very high ceilings. Well, that's laid down in legislation, so now, you can't guarantee that you'll get that staircase, which just comes out of that house 100 percent right at 70 years, there, there, there's nothing wrong with that.	construction decision	change in uncertainty regulations

product oriented	Case7	know your laws and regulations are always changing and what you're going to see, especially if you go to a circular market, look at buildings that are now vacant. They may have been built 50 years ago, that was then, there was a whole different law and regulation. So a number of products you will not be able to use again in the same way, because then they will not comply with the current laws and regulations.	construction decision	change in uncertainty	regulations
product oriented	Case6	Is often, when you are in a tender and ask those questions, then it is all very often focused on the fact that for really big changes people just say 'do now' this time not for a next time than with a current tender, yes then it is changing things by name, are just really not to do and then you know then it has entered into force and then they don't go back more than on the tender. And then you get with that kind. We just don't ask for other things.	tendering rules		regulations
service oriented	Case3	Yeah, yeah, that's, that's, that's very hard to think the councils think, yeah, that might be traditional. But almost everything that yes, what public space is, belongs to them and everything on it, so even if once a tree is on public space. Then you have to get a permit from the municipality and if you stand in your garden, then you can, by way of ordinary per you will also be able to sit victories if it is actually in a monumental thing for example, but yes, so it works with the lampposts as well.	ownership ratio		regulations
product oriented	Case8	Well,basically,look,legally,the landowner is a building owner,but you can make a contract out of that,you can record everything.	ownership ratio	contracts	regulations
product oriented	Case11	So if you have a lift, that's an inseparable part of a real estate property and is therefore quite difficult if you want to, let's say, record that that thing remains the property of Mitsubishi. That's actually not possible at all, because at that moment there is an incomparable part of the whole, namely the building.	ownership ratio		regulations

product oriented	Case5	yes and reasonable tender regulations. That also impedes a lot, eh, so that you always have to apply for more than one party, which by definition means that I don't want to participate in tenders, because that just doesn't make sense, because you put a lot of energy into it in the front, and then it's just thrown on the market and it's the cheapest one that can make it work, eh, because quite a lot is still selected on price, although you can see in the application that points can also be earned for all sorts of other things.	tendering rules	price/competition	regulations
product oriented	Case5	You can on the basis of leasehold can give right of own doing and then you can take the theoretical back to take. Only, you still have all kinds of things where that's not so easy	ownership ratio	lease	regulations
service oriented	Case1	Yeah, and then there's the installation side. We are totally self-supporting throughout our organisation and that starts from the very first advice. Consultant or selling up to and including realization then the transfer, then services and maintenance. And then we have modernisation and one day we will even take it back. So we actually have the whole column in our organisation in the picture.	Personal management		Structure
service oriented	Case1	Not so much at project level. We do that with products that we eventually made. But if you put a new product into design, it will be completely worked out from the front. And then until a total product is actually realized and that is then released for sale.			Structure
service oriented	Case4	Yeah, but of course we are. Look, we do have 85 percent of Then you have to think of the concrete factory, the concrete production, even the factory, the carpentry factory, the bathroom factory. The installations are entirely under our own management. What you don't own is, for example, the kitchen. We buy that.	Personal management		structure
product oriented	Case6	Yeah, yeah, we've got a separate department that does management and maintenance. Could do something like that. We come up with estimates made over several years and we do it ourselves with all kinds of different machines. Solution.	Personal management		structure

service oriented

Case3

Yeah, that's, uh, that's an advantage of ours. We have to stand out. That's actually something a small business medal doesn't have. They only have road construction and they can do a number of projects because they may not employ more than 50 people. Well, we've got everyone 4500. We've got them both ecologists when a permit for Flora and Fauna has to be arranged

Personal management

structure