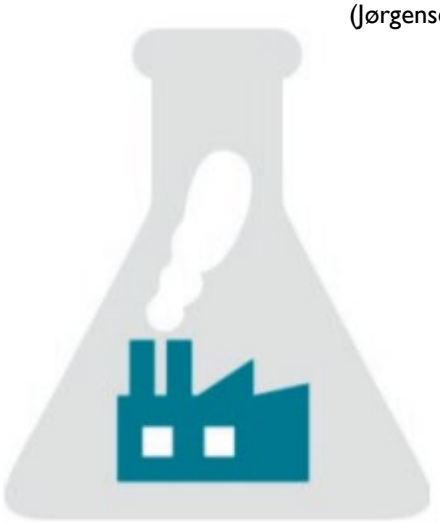
OVERCOMING BARRIERS WHEN IMPLEMENTING A PRODUCT-AS-A-SERVICE BUSINESS MODEL

Overcoming barriers within the transition towards a circular economy by looking at theory and practice

Redesigning a business model is not done overnight, and it is wise not to risk everything on one endeavor. To succeed with business model innovations, companies need to conduct controlled experiments on their business models, in order to uncover what works and why. In that way, they can increase the likelihood that the business model will be successful when it is finally implemented in the entire market.

(Jørgensen & Pedersen, 2018)



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PREFACE

Over the last few years, the concept of the circular economy has grown, and all over the world it has been seen as the way forward. For the protection of our future and our environment, this concept is unmistakably critical. Because of this, having the opportunity to dive into this concept was perfect for me. Looking into the product-as-a-service concept and how this could contribute to the circular economy let me realise how many obstacles it faces. Seeing the obstacles, but also the creativity of the construction sector to deal with them, pushed me to dive into this concept.

Going through this kind of process for the first time, I had the luck to be guided by my mentors. With their help, feedback and discussions I was able to keep my focus and to improve on my findings. Without them, I would not have finished in the same time period as I have right now. Therefore I would like to thank them very much.

Beside my mentors, I would like to thank my family, BOSS board and MBE friends, for being there throughout my graduation. For being the listening ear, where I could present idea, discuss critical standpoints or to simply ask stupid questions. Even though the Corona virus made it sometimes difficult to do so, the zoom meetings and the few days on-campus were the highlights of my graduation process.

And last but not least, my girlfriend, who pushed me, guided me and who made me laugh, at moments when I needed it.

Thank you.

ABSTRACT

The transition towards a circular economy has many barriers. Scholars have researched these barriers in the last few years, though due to lack of implemented cases, practical insights are missing. With a holistic overview, this research connects the theoretical knowledge with insights gained from practice. New insights can be found by looking at the barriers and enablers identified when implementing a product-as-a-service within the Dutch built environment. With the research question "How to overcome the barriers with respect to financial, legal and organisational aspects of implementing a product-as-a-service business model within the Dutch built environment", this research will provide essential insights for a more successful and accurate implementation of product-as-a-service in the future. With the use of multiple cases, the barriers and enablers identified in practice are studied. By combining the barriers and enablers of both perspectives into one list, an overview is created. The gathered findings are analysed according to; the times mentioned, relations between barriers and enablers and the relation between theory and practice. Through a compressed overview, of the most common barriers and the most effective enablers, a ranking is given by experts based on their importance. Based on this research, two ways support the primary research aim. First, the identification of barriers, and secondly, the correct enabler should be chosen to overcome the barrier, through the various overviews provided in the research. To be mentioned is the input given; which is to be used as an indication and helps to overcome the barriers, rather than completely solving the barrier.

Keywords: Circular economy, Product-as-a-service, Barriers, Enablers, Business model.

EXECUTIVE SUMMARY

Over the last few years, Europe has made the shift towards a circular economy (CE) a priority in its policy. Initially, the Product-as-a-Service (PaaS) concept was introduced as a promising approach to create a more sustainable production and consumption pattern (Goedkoop & van Halen, 1999; Mont, 2002). According to Baines et al. (2007), a PaaS is characterised by an "integrated offering of products and services that delivers value in use". Over the past years, multiple studies have explored these service models and the transition towards a CE. Most of these studies have come up with barriers and enablers, containing valuable insights in the implementation of the CE within the current linear economy and existing business models (copper8, 2020; Koukopoulou, 2020; Smeets, 2019). As the literature on the transition towards a CE is rapidly expanding, entrepreneurs are now trying to implement the PaaS concept in practice. Both researchers and practitioners are gaining more knowledge on the implementation of a PaaS business model, though a combined overview of both perspectives is lacking. With a holistic overview, the implementation of the PaaS concept can be stimulated within the Dutch built environment. This research aims at gathering findings from both theory and practice on the barriers and enablers seen in the implementation of the PaaS business model in the Dutch built environment. These findings will provide essential insights for a more successful and accurate implementation of PaaS in the future. Therefore, the main research question is formulated as follows:

"HOW TO OVERCOME THE BARRIERS WITH RESPECT TO THE FINANCIAL, LEGAL AND ORGANISATIONAL ASPECTS OF IMPLEMENTING A PRODUCT-AS-A-SERVICE BUSINESS MODEL WITHIN THE DUTCH BUILT ENVIRONMENT?"

METHODOLOGY

To answer the main research question, the research has been split into four steps. In step 1, the identification of the theory is made. The research method used in this step is a literature review. This method is used to gain knowledge on: the PaaS, the business model canvas, barriers and enablers. In this step and in the following, the three categories concerning finance, legal and organisation are analysed. In step 2, the exploration of practice is done. With case studies, multiple successful PaaS businesses within the Dutch built environment are studied. The case studies are being conducted by a plenary investigation of their product and a semi-structured interview about the barriers, enablers and effectivity of their business strategy, conducted with the business model canvas as a guiding framework. In total, three cases have been selected and analysed according to the business model canvas. In step 3, the connection between theory and practice is researched. With the information gathered in the first two steps, the barriers and enablers from both theory and practice have been synthesised. Through the complete overview of barriers and enablers, the relation is visualised. In step 4, the validation of the overview created in step 3 is done by experts through interviews. As the overview is created to help businesses transition from a traditional business model to a service business model, the consulted experts are managers who are undergoing this transfer or have undergone this transfer in the business model approach. The interviewees are asked to rank the barriers and enablers on importance, to identify the most critical barriers and most effective enablers.

RESULTS

For the barriers, a combined overview of multiple studies, done by leading researchers, is made. For identification of the enablers within the literature, the input of the theoretical barriers was used. The barriers identified are the basis on which the enablers were researched; therefore, the enablers given by theory directly relate to the barriers.

In total, 42 barriers are included in the list. However, some of the barriers were mentioned by multiple researchers. Therefore the duplicate barriers are filtered out, leaving 23 barriers for the overview. The division of barriers is as follows; nine barriers of Organisation, nine barriers of Finance and five barriers of Legal. For the theoretical enablers, 24 were identified and placed in the overview. The division of enablers is as follows; thirteen barriers of Organisation, seven barriers of Finance and four barriers of Legal.

For the barriers identified by practice, interviews were held with three companies providing a PaaS within the Dutch built environment. Adding an extra 65 barriers for the complete overview of barriers makes in total 107 barriers mentioned in this research. As the case studies could provide barriers similar to each other, but also identical to theory, the duplicates are filtered out based on the entire list of barriers of both theory and practice. Resulting in a complete overview of 54 barriers spread over the main categories Finance, Legal and Organisation, with an extra category for "Other" barriers. The final division of barriers is as follows; 20 barriers of Organisation, 17 barriers of Finance, 10 barriers of Legal and 7 barriers of Other. With the enablers identified by practice, an extra 62 enablers for the complete overview of barriers are provided, making a total of 86 enablers mentioned in this research. The duplicates are filtered out based on the entire list of enablers of both theory and practise. Resulting in a complete overview of 71 enablers spread over the main categories Finance, Legal and Organisation, with an extra category for "other" barriers. The final division of barriers is as follows; 33 enablers of Organisation, 18 enablers of Finance, 12 enablers of Legal and 8 enablers of Other. After being synthesised, the amount of enablers has a smaller decrease in comparison to the decrease in barriers after being synthesised. This difference in decrease can be explained due to the reason of having no duplicates in the literature section and the product-specific enablers given by the case studies.

The most common barriers are based on the number of times the barrier was mentioned, and the most effective enablers based on the number of relations with barriers. The overview of the most common barriers and most effective enablers were ranked through expert interviews. By ranking the barriers and enablers per category, the overview was further expanded with experts' opinion. The ranking is done by placing the barriers or enablers in order from most important to lesser importance.

CONCLUSIONS

Based on this research, two overviews are made to support the research aim. First, the identification of barriers. Secondly, the relation between barriers and enablers. First, the barrier should be identified, and secondly, the correct enabler should be chosen to overcome the barrier. Based on the various overviews provided in this research, companies have useful input to overcome the barriers concerning financial, legal and organizational barriers identified when implementing a PaaS business model in the Dutch built environment. However, a mention needs to be made; the input given is to be used as an indication and helps overcome the barriers, rather than completely solving it.

DISCUSSION & RECOMMONDATIONS

The overview given as the final result of the research provides future companies with a perspective on the possibility of barriers and enablers identified within the Dutch built environment. The list of barriers can be used to identify possible barriers, which should be taken into account. The list of enablers gives the company a better understanding of potential strategies that can be included in the business plan. With the table showing relations between the barriers and enablers, the business plan can be aligned. Based on the possible barriers and enablers identified, the company can prioritise their strategy according to the ranking given by experts. By doing so, the companies' focus can be well balanced. However, this research's output should be considered as partial and only used as input during the development of the business plan and not been copied into a final strategy of the companies business.

Experts' ranking on the list of theoretical and practical barriers and enablers can be used for further understanding of the literature on PaaS. As the ranking offers the perspective of experts in practice, the importance of barriers and enablers can be seen. With the barriers and enablers ranked, the literature has gained an extra insight, and this insight can be used to determine the impact of the barrier or enabler. Companies can use the determined impact to address the importance of specific strategies and create an order in their approach to certain problems.

CONTENTS

ABBREVIATIONS

BM	Business model
BMC	Business model canvas
BMI	Business model innovation
CBM	Circular business model
CE	Circular economy
CSC	Circular service contract
EPR	Extended producer responsibility
FaaS	Façade-as-a-service
PaaS	Product-as-a-service
PF	Project Finance
ROA	Return on asset
ROE	Return on equity
SPV	Special purpose vehicle

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01

Introduction

1. INTRODUCTION

In the introduction chapter, the context in which this thesis is written is explained. The problem statement and research aim are defined, and the research questions are given. A short introduction to the research methods used, combined with the research output, is provided in the last paragraphs.

1.1 CONTEXT

Over the last few years, Europe has made the shift towards a circular economy (CE) as a priority in its policy. The Dutch government intends to become completely circular in 2050 and use 50% fewer virgin materials by 2030. For this to happen, every sector needs to change its approach from a linear economy to a CE (Rijksoverheid, 2016; Transitieteam Bouw, 2018).

One of the key sectors where policy change will create a significant impact is in the construction sector (Transitieteam Bouw, 2018), with 50% of the resource use and a production of 25 megatons of waste this sector can have a significant impact on the shift towards CE (Rijksoverheid, 2016). The current system used in the construction sector is based on a linear model of resource consumption. The linear model follows the take-make-dispose concept, which leads to unnecessary resource losses along the value chain. To counter this loss of resources, the idea of a CE is introduced to change the current situation of resource losses, which is not in line with the policy of being 100% circular by 2050.

The circular economy concept is an alternative economic model aimed at reducing waste flows, recycling as many products as possible, and closing material loops (The Ellen MacArthur Foundation, 2013). The CE can be defined as "an industrial system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impairs re-use, and aims for the elimination of waste through the superior design of materials, products, systems, and, with this, business models" (Ellen MacArthur Foundation, 2013, p.7). Creating a CE creates an economic model that reduces resource depletion and associated environmental problems (Ellen MacArthur Foundation, 2013) The definition of the Circular Economy, based on different contributions, of Geissdoerfer, Savaget, Bocken and Hultink (2017, p.759) is: "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling".

According to the European Parliament, the Extended Producer Responsibility (EPR) has top priority in the transition towards a CE (European Commission, 2014). The EPR is an environmental policy approach that makes producers in the post-consumer stage of product still responsibly for the products life-cycle. Both the European and Dutch national ambitions point out that different business models (BM) must help with the transition towards a CE. The EPR concept incorporated into BM is an example of varying BMs necessary for this transition. Looking at Figure 1, existing BM are plotted against the extension of the producer's responsibility.

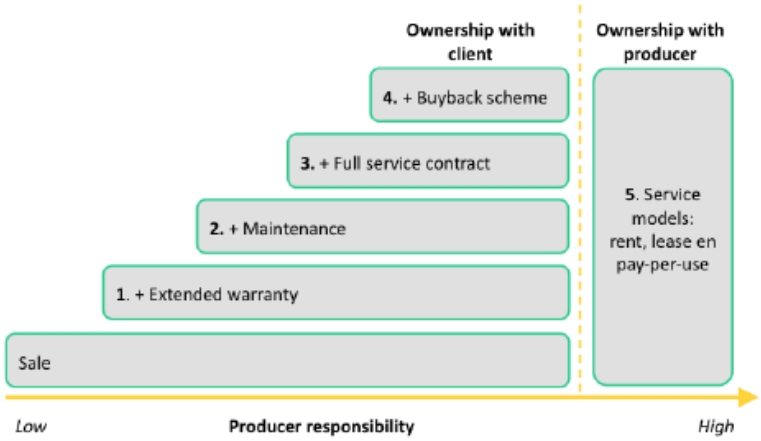

Figure 1. Business models plotted against the producer's responsibility. (Smeets, 2019)

Initially, the Product-as-a-Service (PaaS) concept was introduced as a promising approach to create a more sustainable production and consumption pattern (Baines, Lightfoot, Evans, Neely, Greenough, Peppard, Roy, Shehab, Braganza, Tiwari, Alcock, Angus, Bastl, Cousens, Irving, Johnson, Kingston, Lockett, Martinez, Michele, Tranfield, Walton & Wilson, 2007; Mont, 2002). According to Baines et al. (2007, p.1550), a PaaS is characterised by an "integrated offering of products and services that delivers value in use". The concept of a PaaS has multiple categories showing the degrees between a pure product and pure service. Tukker (2004) mentions three main categories describing the various degrees between a pure product and a pure service, which are; product-orientated, use-orientated and result-orientated.

Adams, Osmani, Thorpe and Thornback (2017, p17) explain the rationale behind the PaaS concept as follow: "by offering a PaaS as a manufacturer, more responsibility is assumed over the lifetime of his products. Therefore, reducing material and energy consumption is beneficial and inclined to happen. To such a degree that PaaS will lead to a decoupling of economic success from ecological impact."

Over the past years, multiple studies have explored these service models and the transition towards a CE. Most of these studies have come up with barriers and enablers, containing valuable insights into the implementation in the current linear economy and existing BM (Azcarate Aguerre, Klein, den Heijer, Vrijhoef, Ploeger and Prins, 2018). Categories frequently mentioned for both barriers and enablers are; Policy & legislation, Technology, Knowledge & Culture and Finance & Economics. Though for each category, new innovative ways are continuously being designed due to the need for change. Contractual forms for new BM are being developed, but are not commonly used. Technology is fast evolving, and new concepts are being generated, but businesses cannot keep up with technology. The knowledge concerning the CE is still immature compared to the current linear economy, but the research into the concept of CE is rapidly expanding. Although our economy's culture is still mostly focused on the linear aspect, frontrunners are showing the potential of this shift in economy approach.

Nowadays, steps towards new BM in the Dutch construction sector are being taken, for example, the Façade-as-a-Service (FaaS) at the faculty of civil engineering at the TU Delft. The FaaS is a PaaS with EPR, which, according to the European Commission (2014) supports the construction sector into becoming more circular. Though according to the findings of the FaaS, multiple barriers are still in place. Also, the theses of both Koukopoulou (2020) and Smeets (2019) emphasise that starting PaaS companies are struggling with financial aspects in combination with legal contracts to spread risks.

Even though multiple entrepreneurs are changing the current situation, the construction sector is still very conservative, and money significantly influences this. Therefore, to start a change in this sector, knowledge regarding the PaaS BM aspects and how to change a BM with product-orientated principles to service-orientated principles.

1.2 PROBLEM STATEMENT

The Dutch government has the goal to become 100% circular in 2050, with 50% of the entire resource use and 25 megatons of waste the construction sector can significantly impact the shift towards a CE. Therefore the transition from a linear economy to a CE of the Dutch built environment significantly influences the ambition of being fully circular by 2050.

With the focus on the EPR within BM, researchers have proposed the PaaS concept as a promising approach to stimulate this transition. Throughout the past years, multiple researchers have studied the concept of PaaS within the built environment. Though, the gained knowledge is still small compared to the literature about the linear economy within the built environment. However, new studies are rapidly providing more knowledge on the subject. The research mainly focuses on implementing the PaaS concept and mentions categories such as finance, legal and organisation. Besides researchers, practitioners within the built environment are taking steps towards a CE through a PaaS BM. As frontrunners, the practitioners are gaining new insights on the implementation of PaaS BM every day.

Although both researchers and practitioners are gaining more knowledge on PaaS BM implementation, a combined overview of both the researcher's and practitioner's perspective is lacking. The rapidly expanding knowledge from both the researchers and practitioners is not yet combined within a study, leaving a gap in the literature.

Both insights gained from the researchers and practitioners perspective are focused on the implementation of the PaaS concept within the Dutch built environment. With the categories mainly discussed by literature concerning finance, legal and organisation, a combination can be made. By combining the insights gained from researchers and practitioners, a holistic overview is made. With this holistic overview, the implementation of the PaaS concept within the Dutch built environment can be stimulated even more.

1.3 RESEARCH AIM

This research aims at gathering findings from both theory and practice on the barriers and enablers seen in the implementation of the PaaS BM in the Dutch built environment. Thus this research will provide essential insights for a more successful and accurate PaaS implementation in the future.

SOCIAL RELEVANCE

Implementing the CE concept has high importance for both the economy and the environment in- and outside the built environment. As not only the economy and environment are affected by the CE concept, also the society, as a whole, is positively influenced. Therefore, developing a strategy to implement the PaaS BM in the built environment can improve the transition from a linear economy towards a CE. As both Dutch and European government have made the transition towards a CE a top priority on their agenda, this research might provide valuable insights into policies, regulations and legislation which influence this transition towards the CE. By providing companies with a holistic overview of the barriers and enablers of both theory and practice, the literature on PaaS BMs becomes more relatable for practice. Lastly, the most significant social contribution; this research paper provides and contributes to the CE concept which ensures a brighter future for future generations that will have the opportunity to use the same resources as our generation has.

SCIENTIFIC RELEVANCE

The application of the CE concept within the built environment is, according to researchers still in its infancy (Azcarate-Aguerre et al., 2018; Koukopoulou, 2020; Smeets, 2019). Zegelaar (2018) has suggested that looking at innovative BMs, different ownership scenarios, and new financing methods support the transition towards a CE within the Dutch built environment. The current literature shows that many barriers and enablers are encountered in the transition towards a CE (VMRG, 2019), but further studies into bringing new BMs into practice are still absent. A holistic overview is created by connecting the theory and practice perspective, adding to the existing literature. With the addition of a ranking by experts, the understanding of the overview is also improved, as most overviews lack information on each barrier or enablers' underlying relevance.

The results of this research are also both socially and scientifically relevant to specific branches within the Dutch built environment such as the façade branches. The façade branches have recognized this research gap and have made a proposition towards the Dutch government to facilitate research into this (Foss & Saebi, 2018; Gordijn, Osterwalder and Pigneur, 2005). Though this research is now being done (Amit & Zott, 2001; Chesbrough & Rosenbloom, 2002; Magretta, 2002), more research is needed to facilitate the transition towards a fully CE within the construction sector. Therefore, this research's conclusions and recommendation can provide valuable and interesting insight for the façade branches into the transition towards a CE.

1.4 RESEARCH QUESTIONS

The introduction and problem statement leads to the following main research question and sub-questions.

"HOW TO OVERCOME THE BARRIERS WITH RESPECT TO THE FINANCIAL, LEGAL AND ORGANISATIONAL ASPECTS OF IMPLEMENTING A PRODUCT-AS-A-SERVICE BUSINESS MODEL WITHIN THE DUTCH BUILT ENVIRONMENT?"

RESEARCH SUB-QUESTIONS

1. What is a Product-as-a-Service business model?
2. Which barriers are identified in the implementation of a PaaS business model in the Dutch built environment from a theoretical and practical perspective?
3. Which enablers are identified to overcome the barriers when implementing a PaaS business model in the Dutch built environment from a theoretical and practical perspective?
4. Which barriers and enablers are the most important for the implementation of the PaaS business model in the Dutch built environment.

1.5 RESEARCH METHODS

The paragraph research methods summarizes the approach taken in this paper, a complete detailed description of the research method is given in chapter 3.

The research consists of four steps; the four steps are shown and described below.

The four research steps;

1. Identify
2. Explore
3. Synthesise
4. Validate

Step 1 Identify; The identification of theory

In step 1, the identification of the theory is made. The research method used in this step is a literature review. This review is used to gain knowledge on: the product-as-a-service, the business model canvas, barriers and enablers. The main categories of barriers identified are; Technical, Financial, Legal and Organisational. In this step and the following, the three categories concerning finance, legal and organisation are analysed. The category of technology is left out of the research, as this is not the researcher's primary field of study. The business model canvas is also introduced to create a guiding framework for the case studies in step 2.

Step 2 Explore; The exploration of the practice

In step 2, the exploration of practice is done. Through case studies, multiple successful PaaS businesses within the Dutch built environment have been studied. The case studies are conducted by a plenary investigation of their product and a semi-structured interview about the barriers, enablers and effectivity of their business strategy, conducted with the business model canvas as a guiding framework. The criteria on which the cases have been selected are based on products with a long lifespan (10+ years), a difficulty to remove (connected to the structure layer or essential to the building performance), a high initial investment, and implemented within an existing company within the Dutch built environment. In total, three cases are selected and analysed according to the business model canvas.

Step 3 Synthesise; The connection of theory with practice

In step 3, the connection between theory and practice is researched. With the information gathered in the first two steps, the barriers and enablers from both theory and practice are synthesised. Through the complete overview of barriers and enablers, the relation between them has been visualised. The overview of relations between barriers and enablers can help businesses navigate the gathered data and help create a business strategy.

Step 4 Validate; The validation through experts

In step 4, the validation of the overview created in step 3 is done by experts through interviews. As the overview is created to help businesses transition from a traditional business model to a service business model, the consulted experts are managers who are undergoing this transfer or have undergone this transfer in the business model approach. The interviewees are asked to rank the barriers and enablers on importance, to identify the most critical barriers and most effective enablers. The overview, combined with the ranking, helps to navigate the findings more efficiently.

To summarise the steps, the research methods used and the research questions, Table 1 is made.

Step	Research question	Research	Research methods	Data collection	Output
1 Identify	1	Empirical	Desk research	Literature review	Analysis of main concepts
	2, 3	Empirical	Desk research	Literature review	Selection of barriers and enablers in theory
2 Explore	2, 3	Empirical	Plenary Case study	Document review / Expert interviews	Selection of barriers and enablers in practice
3 Synthesise	2, 3, 4	Empirical	Summarise	Output step 1 & 2	Overview of barriers and enablers
	4	Empirical	Analyse	Overview of barriers and enablers	List of most common barriers and most effective enablers
4 Validate	4	Empirical	Validation	Expert interviews, output step 3	Ranking of barriers and enablers

Table 1. Overview research structure. (own illustration)

CONCEPTUAL MODEL

This paper's research method and structure have been summarized into a conceptual model, showing the concept of this paper and the relation between those concepts.

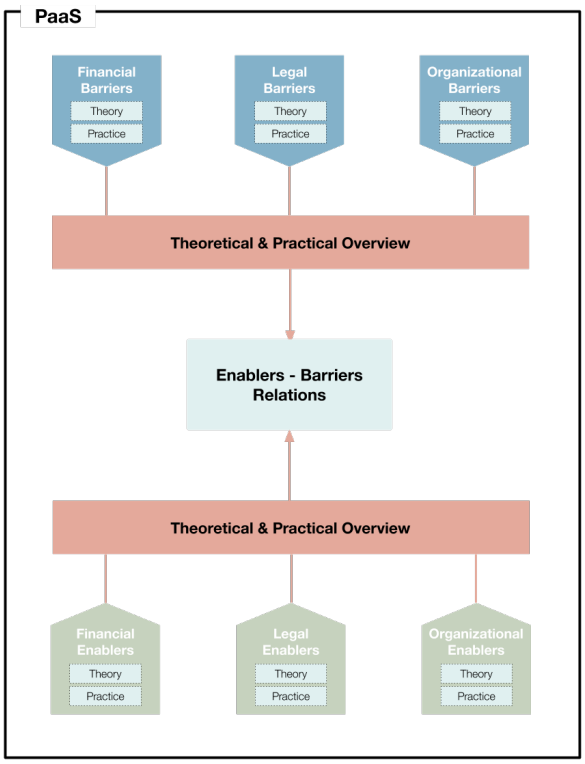

Figure 2. The conceptual model. (own illustration)

1.6 RESEARCH OUTPUT

This research aims to create a holistic overview of barriers and enablers identified in the implementation of the PaaS concept, seen by both researchers and practitioners. With this overview starting companies can navigate the barriers and enablers identified in the implementation of a PaaS BM, to stimulate the transition towards a CE.

The research is split into four steps, each creating different output to answer the main and sub- research question(s).

The first step of the research is the identification of the literature. The research output is gained by a literature review, seen in chapter 2. The output consists of three literature reviews of outstanding researchers on the field of the PaaS concept, combined into an overview of barriers concerning the financial, legal and organisational aspects. The second research output gained within this step are the possible enablers based on the overview of barriers within the literature.

The second step explores the perspective of the practitioners. The exploration is done through three case studies by having semi-structured interviews. The output gained from the interviews are three separate overviews of barriers and enablers seen by the interviewees given in paragraph 4.1.

The third step synthesises the output from step one and two. By synthesising the previous research outputs, the holistic overview is made. Making the holistic overview of the barriers and the holistic overview of the enablers the first research output of the third step. By linking the barriers to their corresponding enabler(s), an overview of the relations between barriers and enablers is created. This overview of relations between barriers and enablers is the last research output of this step. What should be noted is that each overview is divided into three aspects regarding financial, legal and organisational; therefore, each research output is actually a combination of three separate overviews.

The fourth step validates the research output gained in the previous steps and adds extra information. By having three more interviews, the importance of the barriers and enablers are examined. With the interviews, a combined ranking is made as research output for both the barriers and enablers. By adding the ranking of the barriers and enablers to the research output of the holistic overview of step three, the output is further improved. With the addition of the ranking, a complete overview of both barriers and enablers, has been created as research output. The same as in step three, the overviews within this step are split into the main aspects of financial, legal and organisational.

Overall, this research's main output will be the complete overview of both barriers and enablers, helping companies structure their business plan accordingly. This overview will include the three main aspects (finance, legal and organisation), a ranking of importance and visualises the relation between barriers and enablers.

1.7 DELIVERABLES

1. Final report, with;
2. An overview of barriers and enablers seen during the transition towards a service model
3. An overview of the relations between the barriers and enablers
4. The ranking of the most critical barriers and the most effective enablers

1.8 DISSEMINATION AND AUDIENCES

The audience who will be reached through this paper are starting PaaS companies within the Dutch built environment. The holistic overview, including the ranking created in this research, will help the companies transition towards a service model. The overview will help the companies navigate the barriers identified in both theory and practice and therefore stimulate the transition of the Dutch built environment towards a CE.

1.9 PERSONAL STUDY GOALS

Since my minor in technology-based entrepreneurship, I have been interested in the business models of upcoming (pioneering) companies. Especially the practical aspects of management and finance were getting my attention. What makes this business model so special, and does it actually work? During this graduation research, I want to learn more about businesses and the changes they are going through, by learning about things such as a business model canvas and the implementation of a business plan. These skills are valuable in the sector, where I would like to start working. By combining my interest in the business sector with learning valuable skills, I have used my personal goals/interest to create my graduation research.

02

Literature review

2. LITERATURE REVIEW

This chapter explains the basic concepts, barriers, and possible enablers to understand the context in which the case study and theoretical framework are located. In the first part, the BM and PaaS are explained. The second part formulates the barriers found in literature. The last part looks into the possible enablers concerning Finance, Legal and Organisation.

2.1 BUSINESS MODEL AND BUSINESS MODEL INNOVATION

Various studies have suggested multiple types of BM and Business Model Innovation (BMI). By the first appearance of the term BM, early research provided multiple definitions and classifications (Osterwalder, 2004). The BM definition was further extended to understand the BM's components (Osterwalder, Pigneur and Tucci, 2005). With multiple definitions of the BM, an evaluation on general definition was done to find a common pattern among BM. Osterwalder & Pigneur (2011) created with past literature about BM a BM ontology. With the BM ontology, a universally applicable BM definition was created:

"A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams."(Osterwalder et al., 2005, p.17)

With the BM ontology and universally applicable BM definition, nine building blocks have been created, representing the main parts of the business of a firm (Osterwalder & Pigneur, 2011):

1. Value proposition: express the firm's offer of products and services.
2. Customer relationships: Explains how a firm establishes its links to its different segmented customers.
3. Customer Segments: Describes the target customers to whom the value should be offered.
4. Channels: Expresses the different mediums a firm could use in order to reach its customers BM and BMI
5. Key activities: Describes how and which the firm arranges activities and resources.
6. Key resources: Depicts the main competencies required in order to execute the firm's BM.
7. Partner Network: Describes the key partners to execute the firm's BM.
8. Cost structure: Gives information about the costs of the firm.
9. Revenue model: How the company generates revenue.

Richardson (2008) came up with a framework where the nine building blocks of the BM were combined into three blocks focused on the concept of value. With the three blocks, the representation of the BM value can be visualised.

Figure 3. Conceptual business model framework. (Richardson, 2008)

Transitions seen in the BM are referred to as BMI; multiple studies have created a definition for the term BMI. The definition used in this research is that of Baines, Vladimirova and Evans (2007, p.406):

"The conceptualisation and implementation of new business models. This can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another. The transformation can affect the entire business model or individual or a combination of its value proposition, value creation and delivery, and value capture elements, the interrelations between the elements, and the value network."

2.2 PRODUCT-AS-A-SERVICE

The BM of a PaaS, which stands for Product-as-a-Service, is an extension of the traditional way of selling a product by including a service. In the current linear economy, a client typically buys a product and becomes the owner and end-responsible of the maintenance and disposal. In a CE with a PaaS, the product's ownership will not transfer from supplier to client but will remain at the supplier's side and therefore also the responsibility to maintain and dispose of the product. In return for the use of the product, the client pays the supplier for the service provided.

In a linear supply chain, the economy follows the take-make-waste approach: commodities are extracted from the earth, processed, assembled and sold to the market. After the sale, the producer loses control over the product. Most products eventually end up as landfill or are incinerated. There is a lack of incentive to produce durable products. In contrast, producers are incentivised to manufacture products that last for a short period to increase (recurring) sales.

According to Circle economy (2017) the PaaS BM service providers retain ownership of the products and are incentivised to create value by offering high-quality, durable products that can be easily upgraded and repaired refurbished and/or taken back at the end of their life. Figure 4 illustrates that in a PaaS circular supply chain, the retail/sales role is replaced by a service provider. Instead of paying for ownership of a product, in a PaaS BM, the customer pays for functional results of the product and the additional services provided in return for a recurring service fee.

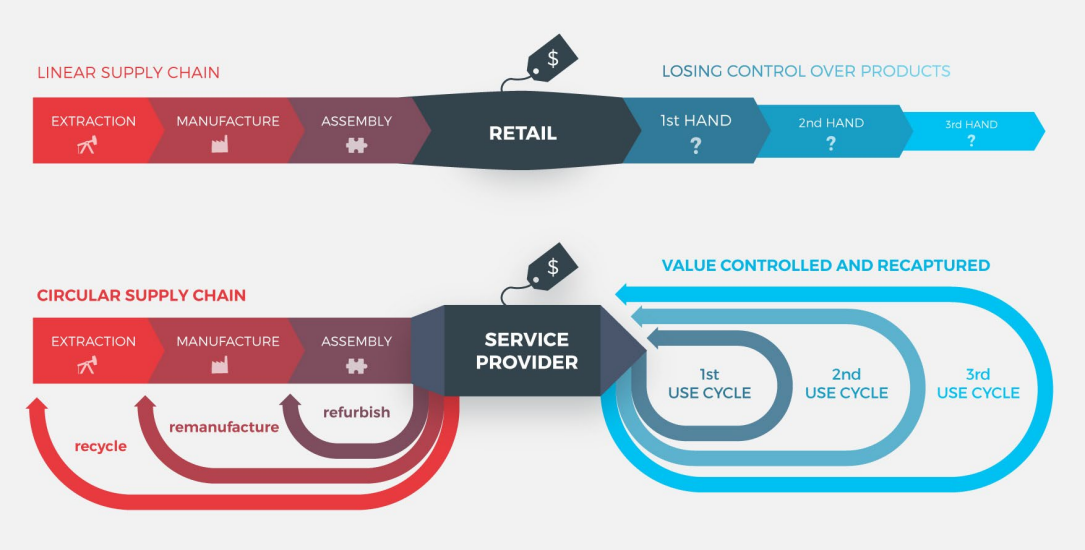

Figure 4. Loops of a linear and circular economy. (Circle Economy, 2018)

The most general definition of the PaaS concept is given by Baines et al. (2007, p.3), who define the PaaS as an **"integrated offering of products and services that delivers value in use"**.

According to Baines et al. (2007); and Tukker & Tischner (2006) the PaaS can be divided into three main categories, each with their subcategories. The main categories are; product-orientated, use-orientated and result-orientated. The PaaS concept is built around a spectrum of PaaS options between a pure product manufacturer and a pure service provider, in which the services and products are combined in various degrees. In Figure 5 the three main categories are placed between the pure product and pure service provider.

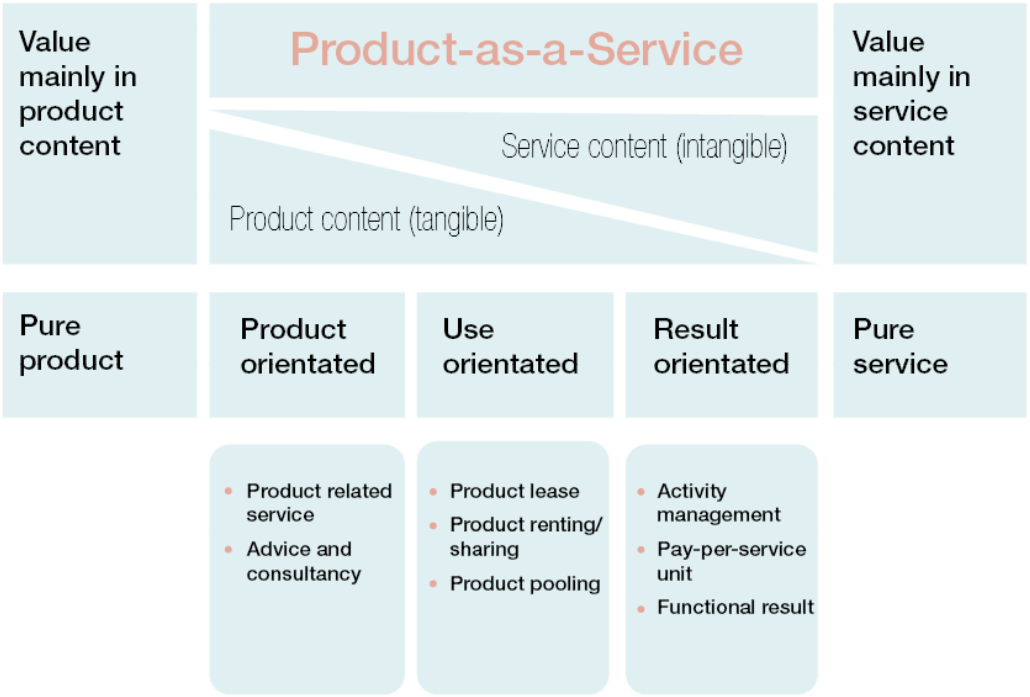

Figure 5. Various degrees of PaaS models and their business model. (Tukker & Tischner, 2006)

As the main definition does not contain the main categories seen for PaaS BM, van Ostaeyen (2014, p.68) defined the PaaS with the spectrum of PaaS options taken into account. Which has been formulated as:

"A PaaS is an integrated offering of products and services with a revenue mechanism that is based on selling availability, usage or performance."

Though the definition incorporates the spectrum of PaaS option, Van Ostaeyen (2014) has added the following understandings for this definition:

- When looking at the BM components, the PaaS is not categorised as a value proposition. The PaaS concept, instead, is seen as a combination of the value proposition and revenue mechanism. Making it more a subsection of the BM, rather than a fully BM.
- Within one BM, there can be multiple PaaS. For example, a combination of selling the product availability and the offering of repairs or maintenance.
- The terms availability, usage, and performance mentioned in Tukker & Tischner's definition refer to the revenue mechanism in the PaaS.

2.3 BARRIERS

Scholars have attributed the limited progress in CE implementation to a variety of CE barriers. Multiple researchers (Koukopoulou, 2020; Smeets, 2019) have combined the research done on CE barriers within the EU and have made a schematic overview containing the essential barriers according to their research (see Figure 6). Kirchherr, Piscicelli, Bour , Kostense-Smit, Muller, Huibrechtse-Truijens and Hekkert (2020) explain the chain reaction seen in practice; barriers are related to each other and affect barriers from different categories, creating a chain reaction. This chain reaction is also shown in the figure below. Based on this chain reaction, some enablers can solve multiple barriers at once, but also cause new barriers to arise. Therefore implementations of enablers to overcome barriers should be tested and monitored, and if necessary changed.

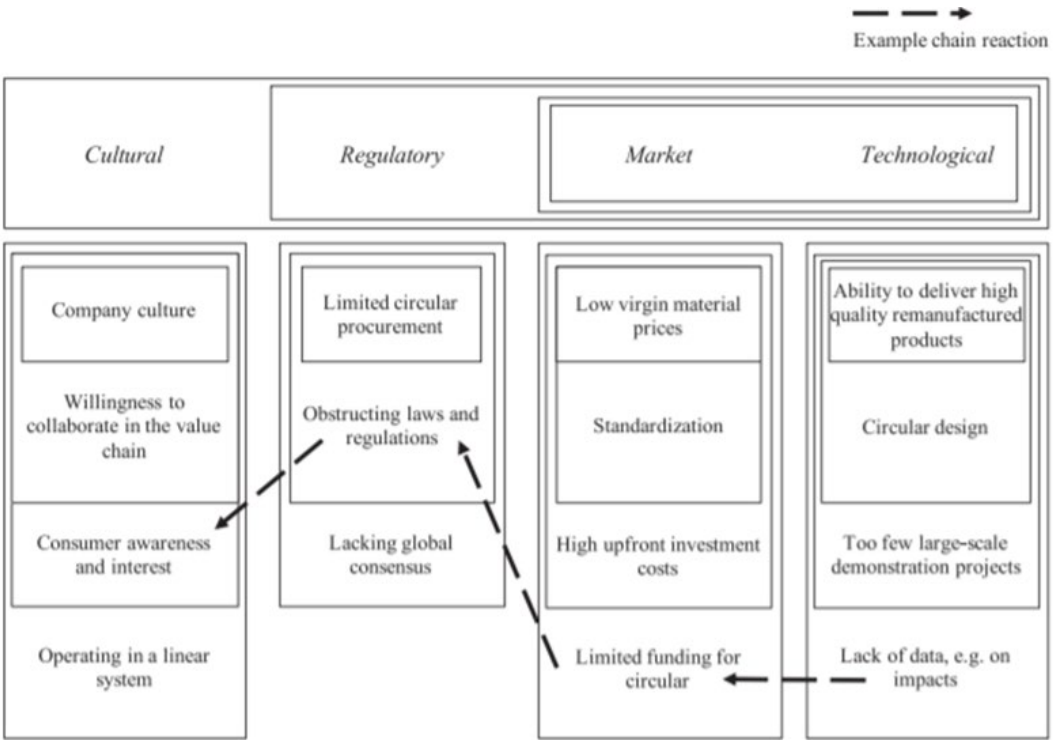

Figure 6. Schematic overview of CE barriers. (Kirchherr et al., 2018)

The research done by Smeets (2019) has created an overview of barriers related to PaaS BM in the Dutch built environment. Smeets (2019) organised the barriers in three categories related to the skin layer, the categories being; Finance & Economics, Legislation & Policy and Knowledge & Culture (see Figure 7). Focus groups consisting of experts have rated the categories based on their opinion of importance, putting Finance & Economics on top, Knowledge & Culture on two and Legislation & Policy on three (Koukopoulou, 2020). Kirchherr et al. (2018); Koukopoulou (2020); Kuo, Ma, Huang, Hu and Shu Huang (2009) also mention two other categories being Technology and Organizational. Both of them have the lowest ranking, according to Smeets (2019), since these barriers can be overcome quite easily according to experts opinion.

CATEGORY OF BARRIER	EXPLANATION
Finance & Economic	• Cash-flow problem • Difficulty defining which party pre-finances the facades components • Façade suppliers cannot make high upfront investments • Financial institutions are reluctant financing the PSS CBM • High investment risk because of lack of track record for façade leasing • High investment risk because of the long lease period • Service solution is more expensive in the long term compared to purchasing one because of risk premiums • Difficulty convincing organizations for financing
Legislation & Policy	• Dutch property law • Taxing system • Bouwbesluit
Knowledge & Culture	• Fragmented nature of the industry raises issues regarding which party keeps ownership of the façade and creates information asymmetry. • Lack of information to balance servicing to the purchasing option • Customers' linear way of thinking • Steel business in particular and the construction industry as a whole is very conservative

Figure 7. Overview of the barriers related to the skin layer. (Koukopoulou, 2020)

In this research the focus is on three categories, being;

1. Financial
2. Legal
3. Organisational

These barriers create a better understanding of how a value proposition can be turned into a BM. Within this proposition, a product and business organisation have already been thought of, and therefore most barriers concerning Technology and Organizational are already overcome.

Many more researchers have tried to make an overview of the barriers identified regarding PaaS BM. Kirchherr et al. (2018) have created an overview of the most frequent barriers suggested in the literature, each coming up with their literature review and findings. To gain an overview of the barriers seen in PaaS BM, these overviews have been analysed and synthesised into one overview to be used throughout this paper (Table 3).

Category	Barrier	Authors
Organisational	Hesitant company culture	(Kirchherr et al., 2018; Kuo et al., 2009)
	Limited willingness to collaborate in the value chain	(Kirchherr et al., 2018; Koukopoulou, 2020)
	Lacking consumer awareness and interest	(Koukopoulou, 2020)
	Operating in a linear system	(Kuo et al., 2009)
	Conservative industry	(Kuo et al., 2009)
	lack of support from senior management	(Kuo et al., 2009)
	Lacking expertise	(Kuo et al., 2009)
	Lack of strategic planning	(Kirchherr et al., 2018)
	Lack of an ideal management information system	(Kirchherr et al., 2018)
Financial	Low virgin material prices	(Kirchherr et al., 2018; Koukopoulou, 2020)
	lacking standardisation	(Kirchherr et al., 2018; Koukopoulou, 2020)
	High upfront investment costs	(Kirchherr et al., 2018; Koukopoulou, 2020)
	Limited funding for circular business models	(Koukopoulou, 2020)
	Lack of data	(Koukopoulou, 2020)
	Cash-flow problems	(Koukopoulou, 2020)
	Difficulty defining which party pre-finances	(Koukopoulou, 2020)
	High investment risk due to long lease period	(Kirchherr et al., 2018)
	Service is more expensive on long term than buying	(Gardner & Wright, 2012)
Legal	Limited circular procurement	(Kirchherr et al., 2018)
	Obstructing laws and regulations	(Koukopoulou, 2020)
	Lacking global consensus	(Koukopoulou, 2020)
	Taxing system	(Smeets, 2019)
	Bouwbesluit	(Brealey et al., 1996)

Table 2. an overview of most common barriers according to theory. (own illustration)

2.4 ENABLERS FOR PAAS

Besides these barriers preventing the transition towards a CE, there are also enablers pushing the CE forward as these enablers are opportunities for companies and hold the key to overcome the barriers. In the following paragraphs for each category enablers are found addressing the barriers given by theory. An overview of the enablers per category is given in the following paragraphs. Even though the enablers given by theory try to address all the barriers, some enablers might be missing. With the input from practice given in chapter 4, the gaps in literature might be filled.

2.5 FINANCIAL ENABLERS

The financial category comes with multiple barriers and is regarded in this paper as one of the main categories in which barriers need to be overcome to successfully implement the PaaS BM. Barriers such as; funding a PaaS model within the construction sector often requires a high initial investment for manufacturing and installation costs. Therefore enablers regarding funding need to be made. So, a financial structure needs to be made specifically for these innovative BM. To find specific financial structure in literature, first, the financial construction for complex projects will be introduced, secondly private funding by lending constructions and as of last the public funding is explored to come up with possible enablers.

PROJECT FINANCE

In long and complex projects, such as infrastructure project, Project Finance (PF) is considered the preferred financial construction. The definition of Project Finance has no universally adopted definition, but in this research, the definition of Esty (2004, p.125) has been adopted:

"the raising of finance on a Limited Recourse basis, for the purposes of developing a large capital intensive infrastructure project, where the borrower is a special purpose vehicle and repayment of the financing by the borrower will be dependent on the internally generated cash flows of the project."

One of the PF's key characteristics is the special purpose vehicle (SPV), in which the borrower has the obligation of realising the project as-is and to pay back the loan on the asset. The PF structure is mostly used because it allocates risks (Rajgor, 2011) between multiple actors with a primarily shared interest in the project's success (Toxopeus, Achterberg and Polzin, 2018). Though when comparing the PF structure and the more traditional model of corporate finance, there are two main distinctions identified. The PF includes an established highly-leveraged SPV, and the SPV provides a minimal guarantee for the sponsors (equity providers) who seek securities on the loans provided (Investopedia.com, n.d.). The minimal guarantee on loans provided is in contrast with corporate finance in which sponsors have recourse on the existing asset if the borrower defaults the loan repayment. Within the PF structure, sponsors look at the project's expected cash flows, to see if it is successfully operated. Because the sponsors depend on the project's successful construction and operation, they are, therefore, stakeholders with a high interest in the project's success.

Due to high interest in the loan and low security provided, PF sponsors carefully inspect such a project. In order to identify risks that would impact the cash flow of the SPV, which would, in turn, reduce the income of the SPV and therefore the ability to repay the loans provided.

To conclude, between the loan approval and the (eventual) debt repayment, the lenders of the PF must carefully analyze the project to identify implications that have a negative impact on the SPV's cash flow and therefore, decrease its capability to pay back the loan provided (Berger & Frame, 2005; Frame, Srinivasan and Woosley, 2001).

PRIVATE LENDING CONSTRUCTIONS

For companies with financial structures such as PF, there are different ways of acquiring loans in the PaaS project's initial phase. According to Hall & Lerner (2010) three types of lending constructs are currently being used to finance PaaS BM; Cash flow-based lending, Asset-based lending & Relationship-based lending.

CASH FLOW-BASED LENDING

Lenders use a financial statement analysis when the audited financial statements have become available to assess funding decisions as a primary information source. Guarantees and/or collateral(s) can be used to secure loans, the monitoring of the loans is done based on loan repayments. According to Berger & Udell (2006, p.2948) the definition of cash flow-based lending is:

> Cash flow lending is a loan granted by a financial institution which is backed by the recipient's past and future cash flows.

Usually, this loan is extended to companies who have a clear and transparent value proposition and value capture when looking at the BMC. However, cash flow-based lending is risky for lenders due to lack of past data (Boot & Thakor, 2000). If the financial statements are not available to be analysed, credit scoring can help lenders to assess cash flows. Credit scoring is an analysis of the entrepreneurs' creditworthiness by looking at the company's financial data. The scoring is typically done through automatic programs and is used on small businesses. Credit scoring is the screening of financial data by using the available information on the firm itself, which is done with automating procedures to evaluate the credibility and is usually used for small businesses (Chemmanur & Yan, 2000; Hendel & Lizzeri, 2002). If the company has no sufficient financial data, loans can be provided by looking at future cash flows and the customers' quality. To gain a loan based on future financial data, the quality of the customer and value proposition components of the BMC are crucial.

ASSET-BASED LENDING

Asset-based lending by banks is assessed by looking at the value and collateral of the company's assets. Berger & Udell's (2006, p.2949) based on Boot (2000) definition of asset-based lending is:

> Fixed-asset lending uses the physical assets of the company which have not been sold during the project's lifespan, and such assets are; real estate, equipment or machines.

The asset's market value determines the loan's size, and the loan repayments are connected to the asset's amortisation schedule. Leasing is a structure based on the assets where the ownership is given to the bank during the loan's lifespan; often the loan structure has a buyback at the end of the contract (Boot, 2000). Working capital loans are given by looking at the current value of the assets such as inventory. The focus of asset-based lending is on the company's physical resources; thus, companies can obtain finance even when revenues are still inadequate. Though, the focus on PaaS's assets within the construction sector is also the difficulty faced when acquiring this type of loan. As the asset is built into the building, the residual value minus dismantling costs are not very high and therefore not considered as preferable collateral with high value.

RELATIONSHIP-BASED LENDING

Relationship-based lending is based mainly on the privately-owned data seen by the bank and borrower only (Boot & Thakor, 2000). Berger & Udell (1995, p.378) definition of relationship-based lending is:

> "The provision of financial services by a financial intermediary that invests in obtaining customer-specific information, often proprietary; and evaluates the profitability of these investments through multiple interactions."

As the definition of Berger & Udell (1995) explains, the observation of the company and the loan is done by continuous, direct contact and observations, by doing so, most of the BMC components are monitored. During the loan, the banks provided the borrower with additional services that help companies' success (e.g. market information, access to customers and other crucial relations) (Brancati, 2015). Due to the lack of track records, cashflows and/or assets, relationship-based loans are being used by small and innovative companies due to the use of 'soft' information (Carpenter & Petersen, 2002). Better relationships between banks and companies lower

the collateral requested (Toxopeus et al., 2018) and increase risks taken by banks for innovation (Rezessy & Bertoldi, 2010). However, it is hard for starting innovative companies to build up a strong relationship when high initial capital investments are needed for the company's existence (Rezessy & Bertoldi, 2010).

PUBLIC FINANCING

To close financing gaps, accelerate the market uptake, and catalyse private investments, the government can offer some support. In case the PaaS model can become commercially attractive, public financing should not substitute private financing, but instead, offer support in the initial phase. According to Rezessy & Bertoldi (2010) there is a wide range of financial structures using public funds to finance PaaS BM. The most common are explained by T'Serclaes (2007):

GRANT PROGRAMS are often given to support initial investments in sustainable projects with high investment costs and long amortisation periods. These kinds of subsidies increase the rate of return on investment by investing in the company. The subsidy also improves the company's cash flow and, therefore, its ability to gain additional finance (European Commission, 2014).

SOFT LOANS are mainly given to energy efficiency initiatives within (residential) construction project (European Commission, 2014). Loan conditions include:

- extended payback periods,
- low or zero interest rates,
- short-term interest deferral periods, and/or
- inclusion of payback grace periods.

REVOLVING FUNDS are used in energy-saving projects, where the money saved, due to the improved energy efficiency, is used to pay off the loan. Grant funds can also be an essential add-on in this situation, by using it as the first-loss position reducing risks for co-financiers in the early phase of the project.

TAXATION can be used in sustainable projects like energy efficiency by incentivising investments into such projects through tax exemptions. Also, capital gain tax, property tax, VAT and accelerated depreciation (Rezessy & Bertoldi, 2010) can be altered to stimulate co-financiers' investments in the PaaS. In Figure 9, a summary made by Mostert, Johnson and MacLean (2010) showing multiple instruments as such as taxations that can be used by a circular supply chain to gain extra financial benefits.

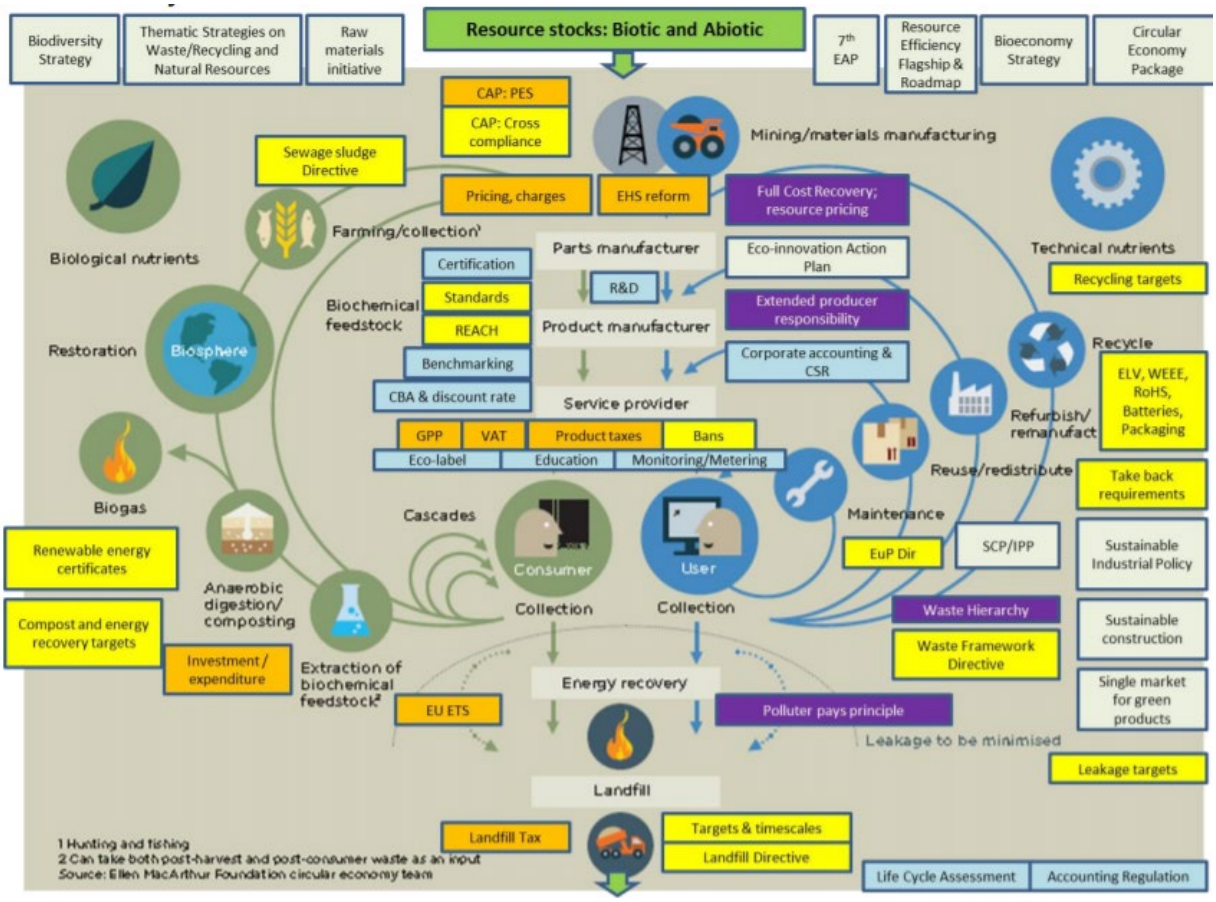

Figure 8. Existing instruments and approaches to support the circular economy in the EU (European Commission, 2008)

RISK SHARING MECHANISMS

For PaaS project with sizeable loans, risks sharing is needed to gain investors on board. The European Commission (Mostert et al., 2010) has defined multiple risk-sharing mechanisms used within the residential sector for energy efficiency projects. Guarantees can be used as a risk-sharing mechanism as it helps bridge the gap between the perceived and actual credit risk, thus providing companies to get the loan needed (Makinson, 2006). Therefore guarantees can be used for PaaS projects by addressing the credit risk barrier of projects with no know future cashflow predictions and/or no collateral available.

PARTIAL RISK GUARANTEES use collateral provided by external partners to guarantee part of the project's loan. This mechanism can improve the project's financial statement when the company itself does not meet the liquidity constraints to get the loan needed. Partial risk guarantees have shown success in jumpstarting innovative programs with the help of local investors. These investors can support an extended loan repayment period and lower interest levels and, therefore, improve the project's feasibility. Also, the investors' debt-to-equity ratio improves the returns (Makinson, 2006).

PUBLICLY BACKED GUARANTEES AND INSURANCE SCHEMES use risk mitigation to direct private funds towards PaaS project (FinanCE, 2016). These guarantees are being used in PF and asset finance (FinanCE, 2016). Within PF structures publicly backed securities support a large-scale, high-risk project with accelerated investments, and in small-scale projects, it solves specific debt and equity problems.

PORTFOLIO GUARANTEES can be put in place to mitigate the financial risks of the SPV related to cash flow income streams. As SPV's rely strongly on debt financing, on-time payments of the client can have a big impact on the repayment of the SPV loans itself.

Though guarantees do not help in every occasion, it should be used as a mechanism within a more extensive program (Fischer, Achterberg and Ballester, 2018). When the main challenge is bank liquidity, guarantees have none or limited use when obtaining financing. Though in markets where investors have no interest in risk-taking, the securities could be used as a mechanism to support the funding of PaaS projects. In PaaS projects where lending experiences are lacking, and limited knowledge is gathered, credit enhancing and risk-mitigating guarantees can help future investments.

COLLABORATIVE CHAIN FINANCING

The circular economy and therefore, the PaaS is based on the assumption that theoretically, the product cycle is infinite, creating a closed-loop of the product. To create a closed-loop, alignment of assets in the supply chain is required. By doing so, the propositions of collaboration provide an added value to both consumer and all chain partners involved Circle Economy (2019). To make this work collaboration between manufacturer, service provider, and other stakeholders in the supply chain are necessary.

The opportunity of resource efficiency lays within the company's ability to innovate the chain collaboration by looking at the up-and/or downstream partners. According to Fischer et al. (2018) the relationship between stakeholders in the supply chain is an essential factor driving or limiting the realisation of opportunities within the CE. Chain collaboration should be clearly stated in the value proposition of a company.

To form a circular supply chain, long-term thinking is needed to look at cooperation between both up-and downstream partners. Due to the product's possible aspects to be aligned with or downstream or upstream processes, the product and company limit its capacity to act flexibly on the market. The loss of flexibility is compensated with long term contracts which secure relevant partners in the supply chain, minimising the risk of losing potential value within the supply chain. By having multiple down- and/or upstream partners, the risks are spread. Though having more partner increases the difficulty in aligning interests to realise the CE within this supply chain. Thus, a balance needs to be found between the risk spreading and securing partners with the difficulty of aligning chain partners interests.

LIMITATIONS COMING FROM FINANCE ENABLERS

Having a loan based on the project's cash flow demands a good understanding of the PaaS BM by investors. However, because PaaS revenues are yet to be conventional in what is now still an asset-based sector, the loan is now often based on the companies credit and collateral besides the project's cash flow. Additional collateral is for most PaaS entrepreneurs non-accessible, and larger companies try to keep loans based on creditworthiness only for core activities only by setting up SPV's for PaaS projects.

One of the limitations of this financing structure (PF) within the construction sector is the low value of the asset after being installed. After instalment, it is often hard to remove and transport to another construction site, making it economically not attractive. Therefore, PaaS assets within the construction sector are often costly and take up a high percentage of the total costs, though the collateral value is low.

On this basis, a loan for a PaaS company is often not based on the value of the assets exclusively, but on the companies' credit or additional guarantees are needed. Also, cost savings on energy are usually not considered in the analysis of available cash flow and the borrower and end-users capability to meet the payments required to pay off the loan.

Public financing can offer financial support but is often complicated and not known to entrepreneurs. Public finance is, therefore, not usually included in the business proposal given to possible investors. By not having public financing in the business proposal, less money or higher interest are provided by investors when asked for a loan.

Financing the change from linear to a circular supply chain requires an extensive analysis of both the borrower and the supply chain. Usually, banks look at the borrower's creditworthiness to set the interest on the loan, rather than examining the entire supply chain. By having a collaborative model, the creditworthiness of the whole supply chain is taken into account, therefore having a positive effect on the loan interest set by the bank. The collaboration model between actors is instrumental in the change from linear to circular within the supply chain. The main uncertainty that the collaboration model holds is if the long term relation will last long enough and if it is legal under competition law. Therefore appropriate commitments for the purchase and supply are needed to mitigate risks in the supply chain.

Given that collaboration within the supply chain is needed, it may be better to finance the entire chain mechanism instead of one actor within the supply chain. Making the borrower a collective of actors within the supply chain of a specific product. Because of this, there is an incentive to align supply chain actors as risks taken, and profit gained is spread over the entire chain. If the whole chain is financed, the collateral is owned by the entity (the chain) as the one granted the loan.

To summarize the enablers mentioned in the paragraph, all are taken as possible enablers. However, each company should choose its own strategy, containing some of the potential enablers. By providing the information given in this paragraph, companies are given the input to decide for themselves. The overview is visualized in appendix A Table 21.

2.6 ORGANISATIONAL ENABLERS

With the identification of a feasible BM, the company needs to make the necessary organisational changes to implement the BM successfully. Especially existing companies transitioning from a traditional model to a PaaS BM. For these companies in particular, Fischer et al. (2018) have developed an organisational change framework to support companies undergoing the transition towards a PaaS BM.

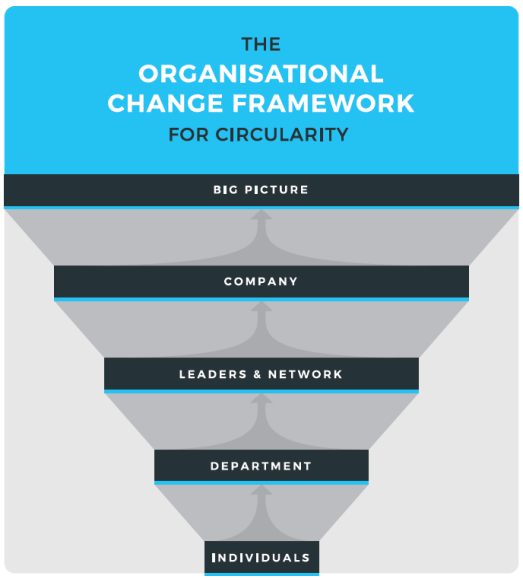

Figure 9. The organisational change framework. (Circle economy, 2019)

The framework developed, focuses on providing direction and capacity building, to provide companies the tool to change their organisation. The tool is based on providing a story line, in which, the individual, the company and the bigger picture are connected.

The following paragraphs describe the different levels of the framework and provide concrete examples. It starts from the big picture and goes back to the individual level ending, concluding with three leading enablers regarding organisational barriers.

THE BIG PICTURE

The shift towards a CE needs more than just the implementation of the new process. It should be connected to a new value proposition and has a different place within the value chain, which requires a change in the organisation culture. By creating a compelling story, employees can be convinced of the necessity for change and inspires them to work together towards the final goal of making the transition towards the CE.

This "big picture" story does not need to be developed by the company itself. Several stories have already been developed by several companies and frameworks that can be used to underline both the necessity for change and the steps that can or must be taken. One of the most frequently cited is the 'butterfly diagram' developed by the Ellen MacArthur Foundation (2013), which offers a visual depiction of what multiple value chains can look like when they are designed to be circular.

COMPANY-LEVEL

At the company level, the "big picture" must be visualised, to show the way forward, both from a sustainability and a business perspective. Through discussion and storytelling, the momentum for action is stimulated. The visualisation of the bigger picture can be done in several ways, which are defined in the following bullet points;

- It is essential to connect the circular approach to what has already been done, reframing and building on existing practices that contribute to the new circular model.
- Integration of circular ambitions in the company strategy and roadmap will help to frame ambition levels, actions, and timelines, and provide increased momentum for action.
- Reinforcement of messages by senior managers as well as key influencers and leaders within the network will strengthen their impact.
- Using tangible examples from inside or outside the organisation and encouraging storytelling helps to bring the subject to life and provide inspiration and shared ownership. Illustrations should also highlight challenges and how they can be overcome.
- It is important to keep messaging simple and to use a common terminology and a variety of channels for communication, continually considering the different interests and language of various stakeholder groups. Examples range from formal training to intranet communications and Twitter feeds, and from a network of leaders to chat groups and videos.

THE DEPARTMENT

To translate the circular ambitions and vision of the senior management interesting and appealing for the people making the operational changes required, the ambitions and vision must be translated. Employees want to understand what it means for them and how they can contribute.

By actively supporting the employees to learn for the functionally-specific knowledge and skills required to realise the ambitions and vision, through for example, function-specific training and training on change management and systems thinking. However, willingness should also be build on, in order to let employees take an active role in the transformation.

THE INDIVIDUAL

Similar to other acceleration programs, it is essential that the momentum and content of progress are not lost, and that circular economy methodology is embedded into the day-to-day working of each team. The work needs to be kept alive and relevant to achieve meaningful organisational .

The translation of learned skills and knowledge into practice and the creation of shared experiences can build additional competencies and networks of good practice, which can attract further action. At the end of each learning cycle and each level, requirements for the way of working should be captured to support continuous improvement cycles and learning loops. This includes embedding deliverables into the procedures and instructions for the team, setting and monitoring targets, and holding ongoing training and awareness programs and interactions with other stakeholders.

THE MOST IMPORTANT ASPECTS

Three interesting enablers that need to be addressed are product development, supply chain management & reverse logistics, and customer-facing functions. These will be discussed in more detail below.

THE DEVELOPMENT AND DESIGN OF PRODUCTS for a circular economy provide real opportunities to capture value from what may otherwise be treated as waste. To realise this value, designers must design using a systems perspective, considering the entire life-cycle of products and their components. Tools and approaches may aid them.

THE SUPPLY CHAIN MANAGEMENT function plays a vital role in implementing circular economy principles since it controls material flows and serves as the interface with parties both upstream and downstream in the value chain. The supply chain management is divided into two parts and further explained in the parts; facing upstream and facing downstream;

FACING UPSTREAM: awareness building and formal training, as well as quantitative scoring for suppliers, can help procurement officers to expand their focus, for example by considering how choices relating to suppliers and manufacturing may impact costs, risks, and product life-cycles; the impacts of different material selection and usage; and the importance of assessing supplier performance on circularity. This can help supply chain managers to better balance technical and functional specifications in order to start a dialogue with suppliers.

FACING DOWNSTREAM: it is increasingly important to gain visibility of the install base at customer sites and to run sophisticated return logistics operations, as companies seek to take back and re-use more equipment as well as to strive for closed-loop recycling. Striving towards zero-waste also requires understanding and the incorporation of more information from re-use and recycling partners downstream. This information can be fed back into the design as well as used to measure partner performance and evaluate material flows. Organisations may also find themselves seeking completely new partners, as the "waste" from one actor in a value chain can become the raw material for another.

AWARENESS CAMPAIGNS: The campaigns and training for customer-facing staff must emphasise the customer benefit and value that the PaaS approach provides, whilst at the same time addressing the way these PaaS BM align with existing sales models and incentives. This may require a broadening of scope for marketing and sales departments, to go beyond product features and quality and toward the long-term total value of customer collaboration.

LIMITATIONS COMING FROM ORGANISATIONAL ENABLERS

In order to change the current linear supply chain, a powerful actor has to initiate the change of a linear to a circular supply chain. Though with the help of the organisational change framework, hesitant culture within the company and supply chain will always be a barrier, as long as the entire industry has not changed to a circular approach. The enablers on the organisational change are focused on the companies who already use a traditional BM, in which they are selling the product. For start-ups this might sound less attractive, as they have more flexibility in choosing employees, and incorporating circular ambitions in the BM.

The steps mentioned in this paragraph have been included in the overview of theoretical enablers in appendix A Table 21. The same as for the financial enablers, they are possible enablers for companies to use as input for their business plan development.

2.7 LEGAL ENABLERS

Barriers concerning the legal status of PaaS is often about the transfer of ownership of the asset. Therefore the enablers explained are focussed around different types of ownership transfers.

OWNERSHIP SCENARIOS

A PaaS implies that the asset has not been transferred ownership making the service provider the legal owner of the product. In order for the client to use the product, he pays a recurring fee. This value proposition of the PaaS is written down in a contractual agreement between parties. Depending on the project and financial situation, the PaaS can structure in several ways when looking at the transfer of ownership. Fischer et al. (2018) has made a comparison between a Design, Build, Finance, Maintain & Plus (DBFM+) and the Circular Service Contract (CSC).

The DBFM+ is an adjusted DBFM contract where the contractor (service provider) has the economic ownership of the product and the client the legal ownership (Smeets, 2019). At the end of the contractual period of the PaaS, there are two options concerning the product.

- **OPTION 1**: the client gets a discount comparable to the residual value of the product on the last payment and has the service provider take back the product. Which is a payback scheme in order to get the product back.
- **OPTION 2**: the product remains at its initial place, while the ownership is transferred from the producer to the client.

The choice at the end of the contractual period is thus to either return the product (materials) or pay the residual value and thus transfer ownership of the product. With the payback scheme, the service provider increases the chance of getting back its product, though a transfer of ownership and retaining the product by the client is still highly likely. Even though this means a second cycle of the product, therefore, is not achieved, the service provider still aims to get the highest residual value and therefore, a longer lifespan needs to be achieved. From the perspective of the accountant, this structure is seen as a financial lease which means that the product appears on the clients' balance sheet.

OPTION 3 is the Circular Service Contract, where the service provider retains the economic ownership of the product and the client has the legal ownership of the product (Bryman, 2012). Ideally, the CSC is pictured as an ongoing service provided and has no end period. By having no endpoint, the product's lifespan is designed to be as long as possible. At the moment that the economic value of the product comes below the residual value, the product should be recycled or re-used (depending on the supply chain). At this moment in time, the CSC should be discussed, and if necessary, the client or service provider can opt-out. If the contract is ended earlier, the financial return of the service provider can be affected negatively. In order to mitigate this financial risk opting out, clausula's should be incorporated into the CSC. As an ongoing service, the ownership does not transfer and will be seen as an operational lease (rental). Therefore the product will be seen on the service provider's balance sheet (Bryman, 2012).

LIMITATIONS ARISING FROM LEGAL ENABLERS

With the circular aspect of the PaaS as main aspect, the CSC has a higher preference than the DBFM+. By receiving payment for the availability of the product, it is better for the service provider that the product lasts for as long as possible. By designing the product to reduce maintenance costs and extending the lifespan, the total cost of ownership is reduced and creates a higher value proposition.

In case a product is physically part of a building, Dutch property law dictates that the ownership right of the product lies with the building owners. Thus, the producers that want to retain ownership over their products in buildings conflict with the Dutch law. Bryman (2012) points out that this creates a barrier towards adopting PaaS BM where producers retain ownership because once the product becomes physically attached to the

building the ownership is automatically transferred from the producer to the building owner. To overcome this, the ownership over the product has to be legally separated from the building. This legal separation of the skin layer needs to be included in the CSC and should be verified by the court before implemented.

As there are three options given, each has been placed in the overview in appendix A Table 21. Especially for the legal enablers, the company needs to research the implication of the legal structure concerning their PaaS.

2.8 CONCLUSIONS ON THE LITERATURE REVIEW

The BM of a PaaS, which stands for Product-as-a-Service, is an extension of the traditional way of selling a product by including a service. In the current linear economy, a client normally buys a product and therefore becomes the owner and end-responsible of the maintenance and disposal. In a CE with a PaaS, the ownership of the product will not transfer from supplier to client but will remain at the supplier's side and therefore also the responsibility to maintain and dispose of the product. In return for the use of the product, the client pays the supplier for the service provided. With the extra responsibility of maintenance and disposal of the product, barriers arise. The main barrier categories mentioned by leading experts on the field of PaaS, are used throughout this research. The main categories being;

1 Financial
2 Legal
3 Organisation

These categories will be used to create a better understanding of which barriers are arising when implementing a PaaS BM. Barriers involving technology are taken outside of the scope, as this too product-specific and outside the expertise of the researcher.

Multiple researchers have created an overview of the most frequent barriers suggested in literature, each coming up with their own literature review and findings. To create a complete overview, each of the barriers mentioned by researchers is placed in a combined overview of barriers. The barriers which are mentioned by multiple researchers are merged into one barrier within the list, to remove duplicates. The overview is seen in appendix A Table 20.

The overview of theoretical enablers is created by searching for possible enablers for the barriers mentioned in paragraph 2.3. For each barrrier an enablers is found and elaborated on, the overview of all the enablers in theory is given in Appendix A Table 21.

The overview of barriers and enablers made in this chapter represents the theoretical perspective for this research. By using multiple literature reviews and combining them, the theoretical perspective includes a broad spectrum of known barriers and enablers. With the first overview made in this research, a template is created for the next overviews of both barriers and enablers. Also by creating the overview, a template and background information is formulated to be used during the semi-structured interview and understanding of the cases. The overview will be used further on in the comparison of the interview results, and after that extended into an overview with both theory and practice.

As the enablers given in the literature study are based on the barriers mentioned by leading experts, the enablers have a direct link to the barriers. However, limitations on the enablers are present and should be taken into account. The enablers are mainly theoretical and implementation in practice of some enablers are untested. With the overview of the enablers a study is done into the known possibilities and scenarios on how to implement a PaaS BM. The knowledge on the possibilities is especially useful for the ranking and validation interview, where the strategies used by companies are mainly influencing there opinion on the importance of both barriers and enablers.

Overall the gained knowledge and the overview resulting from this chapter form the current perspective on the PaaS implementation. With the current perspective from a theoretical standpoint visualised in an overview, the case studies have been conducted to find out the difference between the theoretical and practical standpoint.

03

Research methods

3. METHODOLOGY

The research aim, presented in the first chapter, is to create an overview of barriers and enablers seen in theory and practice, and with this, show their relation in order to help businesses transition towards a PaaS BM. To create an overview and show the relation between theory & practice and barriers & enablers, the research paper is divided into four steps; Identifying, Explore, Synthesise and Validate. As explained in the first chapter, the first step is to identify both barriers and enablers in theory. Step 2 explores the practice through case studies. Step 3 is the visualising of the relation between the data of step 1 and 2. Step 4 will validate the overview with experts within the Dutch built environment in order to come up with a ranking. The structure described is summarized in Table 1; the visualisation of this is seen in Figure 12 to show the inner relations between each part.

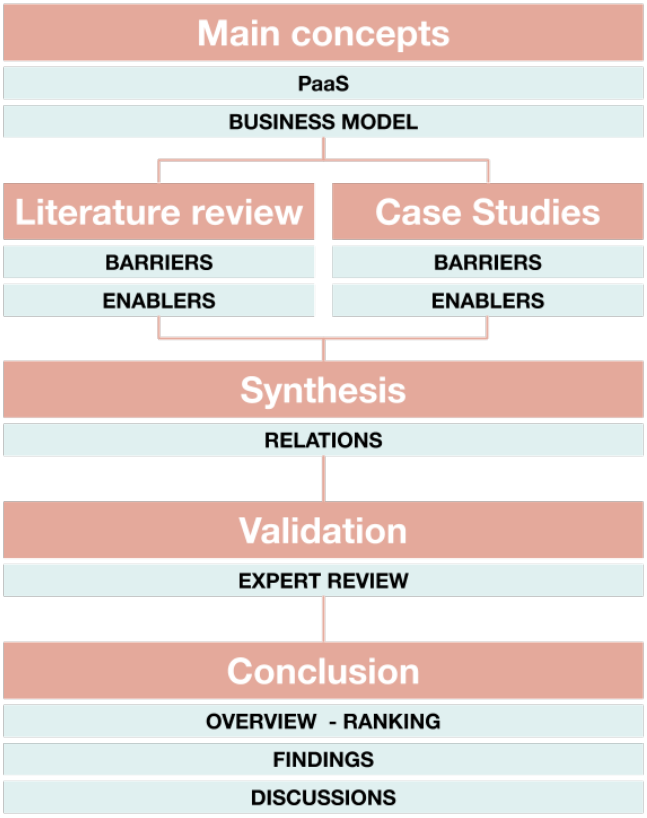

Figure 10. Research structure. (own illustration)

3.1 STEP 1 IDENTIFY: THE IDENTIFICATION OF THEORY

A literature review is a critical examination of existing research relating to the phenomena of interest and of relevant theoretical ideas (Bryman, 2012). Bryman (2012) created the literature review as a strategy to gain knowledge on:

1. Current knowledge on the topic;
2. Which theories and concepts are used;
3. Which type of research methods are already used;
4. Which controversies surround the topic;
5. If there are clashes between the findings of the topic;
6. Who are the main researchers on the topic

3.1.1 DATA COLLECTION

The data collection of the literature is done mostly through online sources. In order to collect and search for the literature used in this research, the steps of Bryman (2012) are used as guidelines throughout the process (see Figure 13). The data analysis for the literature review can be done by using a narrative or systematic approach to the literature (Bryman, 2012). In this report, the narrative approach is used for the literature review.

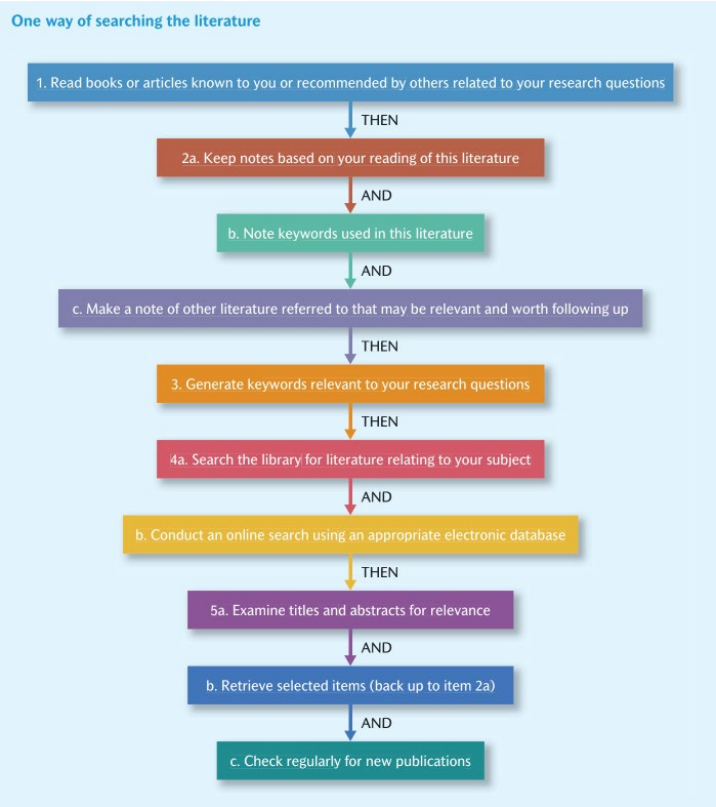

Figure 11. Steps of searching for literature. (Bryman, 2012)

THE LITERATURE APPROACH

Step 3 of Bryman (2012) is to generate keywords used/relevant for this study. Based on these keywords, literature is found and formulated. The keywords are derived from the main research question and sub-questions. For this research, the key terms used are; Product-as-a-service, Business model, Business model canvas, Barriers & Enablers.

The structure of the literature review is based according to the key terms, with the same order as described in the paragraph above. First, a main description of the key terms is given, after which both barriers and enablers within the theoretical studies are explained.

3.2 STEP 2 EXPLORE: THE EXPLORATION OF PRACTICE

Case studies are a research methodology to research (a set of) events, aiming to describe and explain a subject of interest (Yin, 2003). This strategy is usually taken when research questions begin with 'how' and 'why'. In this step, the questions; "Which barriers are encountered, and how has the company tried to overcome these barriers?" are the main questions asked throughout the case studies. Research questions 2 and 3 are the sub-questions that are answered with the use of multiple limited case studies within this step.

3.2.1 DATA COLLECTION

The data collected for the multiple case studies are done by conducting interviews with well-established PaaS companies within the Dutch built environment. The information gathered is derived purely from the interviews, as the data needed is about the barriers and enablers within their business plan. Therefore the case study is limited and based on interviews with a key player in the company, such as a CEO or senior manager. There are two options for conducting an interview, being: unstructured or semi-structured interviews (Yin, 2003). According to Sekaran & Bougie (2016); The unstructured interview can be seen as a conversation rather than an interview as it starts with a single question without any further guidance. The semi-structured interview follows a list of questions which guides the interview.

3.2.2 THE CASE STUDY METHODOLOGY

The method used for the case studies in this research is semi-structured interviews. For the semi-structured interviews, the questions do not have to be exactly asked as outlined in the interview proposal; also, room for additional questions is allowed. Though strived is that most of the questions will be asked during the interview. This to compare interviews and to analyse the outcome afterwards (Baxter & Jack, 2008).

The definition of case studies by Yin (2003, p.13) is: "an empirical enquiry that investigates a contemporary phenomenon within its real-life context, where the boundaries between the phenomenon and context are not clearly defined, and in which multiple sources of data collection are used". The method of a case study is applicable when the research is into the understanding of events, and are used for understanding used enablers to current barriers based on past experiences Gustafsson (2003).

In the case of this research, the methodology is used to create insights in the implemented barriers and enablers used within the PaaS BM in the Dutch built environment.

3.2.3 THE CASE STUDY DESIGN

The case study design is done according to the four steps of Gustafsson (2003):

1. *Unit of analysis*

The barriers and enablers identified in the Dutch built environment when implementing a PaaS BM.

2. *Determination of the type of case*

The exploratory type is used, as the aim is to explore and map barriers and enablers.

3. *Binding of the case*

The boundaries of the case are measured by the type of BM, location, maturity, industry and investment needed. The used boundaries are further detailed in Table 4.

4. *Single case study or multiple case studies*

With multiple case studies, there are two or more case studies done. According to Yin (2003) based on Seawright & Gerring (2008) multiple case studies are used to gather data from various cases in order to identify

differences or similarities. With the identification of the differences and similarities between the cases, the overview of barriers and enablers implemented in the PaaS BM can be strengthed.

With the choice of a multiple case study, the representativeness is ensured (Osterwalder, 2004). The extra argument made by Cruzes, Dybå, Runeson and Höst (2015) is that the method strengthens the conclusions and creates, therefore, a more conclusive theory. This due to the amount of empirical evidence gathered, which is critical, knowing that the implementation of PaaS BM is not mainstream.

The use of multiple case studies in this research is visualised in Figure 14 and is comprised of three steps:

1. Define and design
2. Prepare, collect and analyse
3. Analyse and conclude

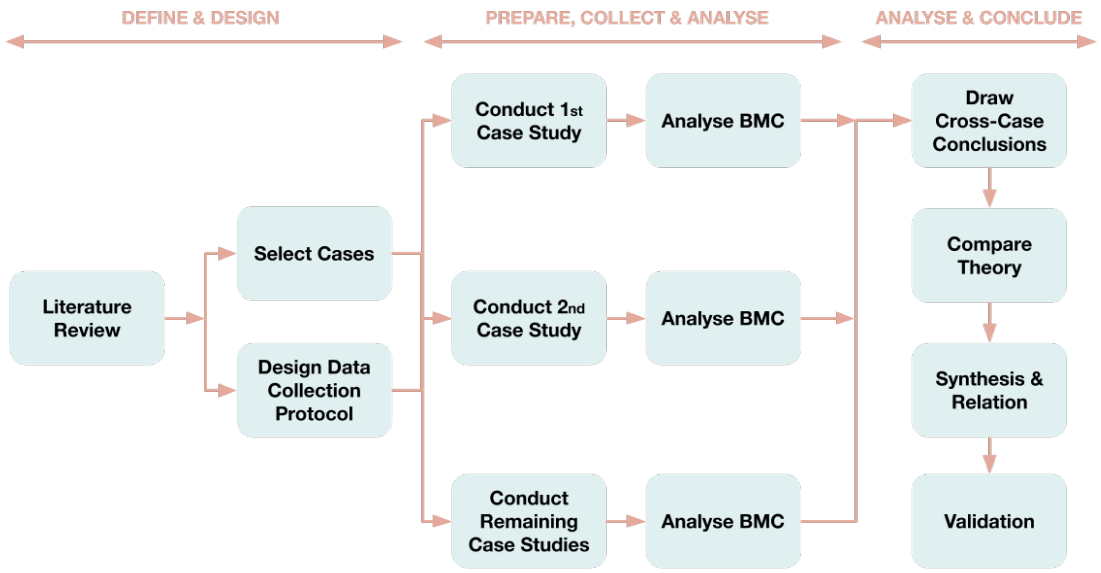

Figure 12. Flowchart of case study methodology design (own illustration based on Yin (2003))

Each step is presented and analyzed in the following section.

STEP 1: Define and design

In this step, the theory is analysed, case selected, and the interview protocol is made.

THEORY DEVELOPMENT

The theory development contains the literature needed to prepare for the interviews. As the literature gathered in the literature review relevant to the topic will be analysed within the case study (Osterwalder & Pigneur, 2011; Osterwalder et al., 2005). The theory development is further given in step 1 "Identify".

CASE SELECTION

The case selection is made with the strategy of the criterion sampling, where a set of criteria helps determine the cases.

The criteria for the case selection is explained in Table 4. Five criteria are formulated by the researcher, namely the type of BM, the location, the maturity, the industry and the initial investment needed. The cases were identified through the researcher's supervisors and the cases mentioned by research institutions.

Criteria selection	Criteria explanation
Type of BM	PaaS
Location	Netherlands
Maturity	In the operation phase
Industry	Dutch Built Environment
Investment needed	High initial investment

Table 3. Criteria of case study selection. (own illustration based on Cha (2017))

Company	Type of service	Layer
Madaster	platform as a service	-
The Dutch mountains	Buildings as a service	-
Twunstra Gudde	Real estate as a service	-
Dura vermeer	Road as a service	-
M.J. Oomen	Water as a service	Services
Eneco & Delta development	Climate as a service	Services
Mitsubishi	Elevators as a service	Services
THE FCTR-E	Energy as a service	Services
TU Delft	façade as a service	Skin
SUNPOWER	solar panels as a service	Skin
Alkondor Hengelo	façade as a service	Skin
Philips	Light as a service	Space plan
Ledlease	Light as a service	Space plan
Desso	Carpets as a service	Space plan
Interface	Carpets as a service	Space plan
Bundles	Washing machines as a service	Stuff
Homie	Machines as a service	Stuff
Ahrend	Furniture as a service	Stuff
Auping	Matras as a service	Stuff
Chainable	Kitchen as a service	Stuff

Table 4. List of potential cases with PaaS BMs. (own illustration)

The list of potential cases are made with some of the selection criteria already taken into account, like the location and industry criteria. However, a criterion not yet added concerns the technical comparison between cases. As concerns, the companies which have applied the PaaS BM for products in the Stuff or Space Plan layers were not included into the case study analysis, due to the main reason of technical relevance compared to each other and the probability of high initial investment needed. Therefore, services as Madaster can also be left out

of the final selection. Looking at the phase the company is in right now; also, some of the cases can be left out. Cases as the façade-as-a-service from the TU Delft and Alkondor are still in their development phase and therefore do not match the criteria. This leaves the following list of companies for the case studies (see Table 6).

Company	Type of service	Layer
Dura vermeer	Road as a service	Infrastructure
Mitsubishi	Elevators as a service	Services
Philips	Light as a service	Space plan
Ledlease	Light as a service	Space plan
Alkondor	Façade as a service	Skin
The FCTR-E	Energy as a service	Services
Chainable	Kitchen as a service	Stuff

Table 5. List of potential cases after criteria selection. (own illustration)

DESIGN OF THE DATA COLLECTION PROTOCOL

According to Osterwalder (2004) the data collection protocol consists of:

- The two sub research questions which will be answered: "Which barriers are identified when implementing a PaaS BM in the Dutch built environment?" & "Which solutions are identified in order to overcome the barriers when implementing a PaaS BM in the Dutch built environment?"
- The final number of the cases: minimum of 3 maximum of 5
- The data collection procedures: Face to face interviews and desk research
- The case study interviews objective: The PaaS BM strategies, which have been implemented in practice to overcome barriers in respect to Finance, Legal and organisation. In order to create an overview of both barriers and enablers.
- The questionnaire: An interview questionnaire (Appendix B) was based on the BMC.
- The place and time of the interviews: around 45 minutes at the location of the interviewees' demand.

To analyse the multiple case studies, a framework is used; this framework is the BMC (see Figure 15). The BMC is used to guide the semi-structured interviews and to gain similar results from the interviewees by looking at their entire BM. The BMC has nine characteristics of a BM, of which it is not expected that each case study has strategies implemented in all of the nine characteristics, though the framework will represent their entire BM and is therefore of great use. With the use of the BMC the barriers and enablers seen throughout their BM can be identified.

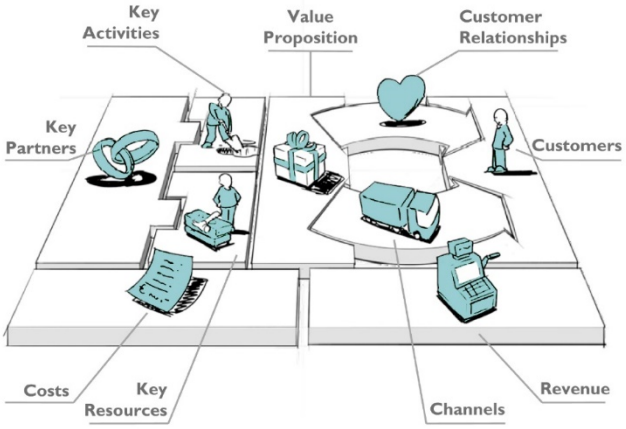

Figure 13. The business model canvas. (Cruzes et al., 2015)

STEP 2: Prepare, Collect, & Analyse

- Ask to interview and record
- Transcribe
- Analysed according to BMC framework

STEP 3: Analyse & Conclude

In step 3, the analysis is made, and the findings on the case studies are formulated. The main part is the cross-case analysis, where the synthesising of the cases is done. The successful implementation is done by the presentation of various data in tables or graphs (Osterwalder & Pigneur, 2011; Osterwalder et al., 2005). The BMC will create the framework in which the cross-case analysis will be executed in order to extract similar data to compare the cases.

3.3 STEP 3 SYNTHESISE: THE CONNECTION OF THEORY AND PRACTICE

With the theoretical information gathered in step 1 and the input from practice from step 2 a comparison can be made. The comparison between theory and practice helps create the final overview with the findings from both perspectives. The comparison is made according to the following steps:

1. Identification of duplicates
2. Relation between barriers and enablers
3. A condensed overview of most common barriers and most effective enablers

STEP 1. identification of duplicates

As both theory and practice are separately researched, the data contains an overlap in barriers and enablers mentioned. To synthesise the data input, the duplicates are filtered out. The number of times a barrier or enabler is mentioned is used to find the most common barriers and enablers within theory and practice.

STEP 2. Relation between barriers and enablers

The created lists from step 1, are plotted against each other in a table. Within the table, the relation between each barrier and enabler is visualised. The number of relations one enabler has with the barriers is used to gain insight into the effectiveness of each enabler.

STEP 3. A condensed overview of most common barriers and most effective enablers

Step 1 and 2 create an overview of the most common barriers and the most effective enablers identified in both theory and practice. This condensed overview is used for the next research step "validate".

3.4 STEP 4 VALIDATE: THE VALIDATION THROUGH EXPERTS

The validation is done to analyse the output of step 3 "synthesise" and improve the outcome. The used research method is an interview with experts, discussing the overview of the most common barriers and most effective enablers. An expert review is where an expert in the field of study tries to use his knowledge and experience to give a further explanation of the findings. The expert review is done to create a ranking within the list of barriers and enablers to further understand the relations between them. Three experts from practice are asked to rank the given barriers and enablers on importance, which are then combined to gain a final ranking.

04

Results

4. RESULTS

In this chapter, the interview results and analysis are presented. First, the results per case study are shown. Secondly, the case analysis is presented. Finally, the results of the case studies and the theory are compared.

The results are visualized and analysed as follows: The interview data is organized according to the BMC, this already provides a first overview of the entire BM, and therefore, it is a starting point for the visualisation and analysis of the case study. Secondly, the Barriers and Enablers are divided between the main categories, as explained in paragraph 2.3 Barriers. By dividing the barriers and enablers over the categories Finance, Legal and Organisation, a comparison with theory can be made. As not all of the barriers and enablers seen in the case studies are directly linked to the main categories, a fourth category "Other" has been added. Thirdly, the comparison between theory and practise for each case study is done to see the main focus of barriers and enablers. Fourthly, The barriers and enablers are combined, and the barriers and enablers which are mentioned multiple times, are filtered out. The barriers mentioned the most are common barriers that numerous companies can encounter, making them essential to address. The following step is mapping the relation between various barriers and enablers to create an overview of barriers connected to multiple enablers and vice versa. The most effective enablers are found by looking at the number of barriers related to the enabler. With the most common barriers seen in step four and the most effective enablers seen in step five, interviews with experts are done to create a ranking to find the most important barriers and enablers. At the end, a final conclusion on the results presented within this chapter is given.

4.1 CASE STUDIES RESULTS

Paragraph 4.1 case studies results, gives the results of the interviews with three companies in the Dutch built environment offering different PaaS. The results are derived from the interview questions seen in Appendix B.

4.1.1 MITSUBISHI

Mitsubishi Electric is worldwide one of the best suppliers in reliable and sustainable elevator- installations, maintenance and renovations. In Asia, they are the market leader in the elevator service, and in western Europe, they are expanding significantly in the segment of high-quality projects. With an office in Veenendaal in the Netherlands, they have been for over 67 years a trusted company in the Dutch built environment. With the concept of the M-use, they have entered the market of PaaS. The M-use concept entails the offer of carefree vertical mobility within a building. Meaning they offer the service of an elevator and the maintenance that comes with the elevator. The M-use concept has been around for several years and is now more than 60% of the annual revenue of Mitsubishi Electric in the Netherlands. Making the concept of an Elevator-as-a-Service a successful business and a perfect example of PaaS BM in the Dutch built environment.

BARRIERS AND ENABLERS OVERVIEW

The output of the interview questions regarding the business of Mitsubishi's Elevator-as-a-Service has been visualised in Appendix C Case analysis Mitsubishi. In the overview of Table 6 the same barriers and enablers of Appendix C Table 22 are pictured according to the main categories; Finance, Legal, Organisation and Other. These are the barriers and enablers used for the analysis of the Mitsubishi case.

Barriers			
Finance	**Legal**	**Organisation**	**Other**
Way of pre-finance	Retaining ownership	Conservative environment	How to implement longer lifespan
VAT extension on product	New contract needed	Existing company changing into a new way	Some segments are just not a fit
limited own resources	Risk of an early contract ending	Little PaaS thinking	No knowledge of service being provided
Intensive trying get contract with a bank, will not be a perfect fit	No known contracts in the market	Not having expertise inhouse	No market demand yet
calculate end value and how to enlarge it	Too much due diligence on contract	Not in DNA	
Not enough income on service alone	Risk of a bad contract	The staff does not fit this thinking	
		longer traject with partners (compared to just selling)	
		Getting dedicated commitment from partners in supply chain and maintenance	
		Most future clients don't know PaaS yet	
		The staff has limited knowledge of PaaS	
Finance	**Legal**	**Organisation**	**Other**
Validate financial model, contract with financier	Research with an external notary	Talk and offer circular PaaS option	Add intelligence (sensors), new maintenance approach
Fiscal research and calculate	Create a new contract with KPI's	A lot of marketing	Just take small steps, if not perfect search further
Contract with financier	Risk inventory	Educate/replace staff	just respond with PaaS instead of traditional product
giving the product a second life, create an end value	Invest, find new expertise people, talk with clients about contract forming	Create a contract with an external partner	Create attention by going to exhibitions, lectures, or use pilot projects as an example.
	Optimise by doing	Understand that it's a different world, don't push it	One big developer, to gain a big order in one time
	contract making, using, changing, validating	Believe in your service, stand vast	
		Dedicated PaaS account manager	

Table 6. Overview of Mitsubishi's barriers and enablers according to the main categories. (own illustration)

BARRIERS IN COMPARISON WITH THEORY

To analyse the data received from the interview with Mitsubishi, a comparison with theory from the literature study is made. First, the barriers and differences are examined. Secondly, the enablers are compared, after which conclusions are drawn about the similarities and the differences between the case study and theory.

FINANCIAL BARRIERS

The comparison of the barriers (shown in appendix C in Table 23) between theory and the case of Mitsubishi show several differences and similarities. First, the barrier of "way of pre-financing" is seen as an umbrella barrier within the category of Finance. Meaning; the barrier of "way of pre-financing" is a general barrier that entails barriers such as "own limited resources" where the company cannot pre-finance the business as his financial resources are limited. Also, the barrier of "lack of data" gives companies and banks a hurdle to overcome before pre-finance arrangements can be made and therefore is a sub-barrier of the "way of pre-financing". Especially the theory goes more into detail about the different barriers that make pre-financing difficult. The case study of Mitsubishi tells more about financial struggles throughout the BM and therefore, does not go into the same details as the theory goes. The barriers mentioned in the interview tell about the financial barriers of the product itself, which are the VAT extension and the end value calculation of a used product. These are barriers that are seen by Mitsubishi but have not been overcome yet, as the VAT extension is a policy they cannot change and the end value calculation is complicated as no research yet has explained on how to apply this to circular products. The barrier of "intensive contact with a bank" given by the case of Mitsubishi goes more into the setting up of a loan, but show correctly the barrier seen between the lack of knowledge of external key partners and the difficulty of getting pre-finance. Therefore this is a barrier not to be underestimated by starting companies in the transition towards a PaaS BM.

LEGAL BARRIERS

Looking at the barriers of both theory and the case of Mitsubishi (See appendix C Table 24), a difference in focus is found. The theory focusses on the barriers created from multiple different perspectives, such as; Law, Policies, contracts and current systems. The case of Mitsubishi focuses more on the barriers the company has encountered and which could still be overcome. Meaning they have not looked at the barriers they have no influence on, such as the taxing system and obstructing laws and regulations. Instead, Mitsubishi mentioned barriers such as contract development or contract management and the risks involved with new as-a-service contracts. Therefore, even though both give different barriers, they are not contradicting each other. The theory is looking at all the barriers seen within the Legal category, and Mitsubishi is looking at the Legal barriers they can influence, rather than looking at barriers they cannot overcome by themselves.

ORGANISATIONAL BARRIERS

Seeing the barriers given by the case of Mitsubishi and the theory for the category of Organisation (See appendix C Table 25), a comparable outcome is visible. Both the theory and the case give a variety of barriers on multiple levels within the company. Mitsubishi is mainly focused on the introduction of the new concept of a PaaS, where the inexperience from the company, employees, clients and external partners impacts the functioning of the company and is therefore seen as an essential category that cannot be overlooked. As both the theory and case of Mitsubishi see the inexperience with the PaaS concept as a significant barrier visible in many layers of the company, though differences might be seen in which layers they recognize the barriers. Just as the theory, the case of Mitsubishi mentions barriers in all of the levels (being: big picture, supply chain, department and employee/client). Though each barrier might be formulated differently, they are focused on the same organisational levels of the company and supply chain. Therefore, the theory and case are similar, but are still mentioning different barriers.

OTHER BARRIERS

Other barriers given during the interview are extra barriers, which the company considers relevant and should not be overlooked. Therefore it is worth to be mentioned during this research as it is additional input for the overview of barriers. The first barrier is about implementing a longer lifespan by using the butterfly diagram of the Ellen McArthur Foundation (2013). The extended lifespan is an essential aspect of the CE, but has significant technical difficulties and is, therefore, a barrier not to be overlooked. The second barrier is about the customer segments; some existing customers simply do not match the new concept of a PaaS; therefore, the transition towards a service model might result in a loss of existing customers. The third barrier is a barrier addressed through this paper's making, as there is limited knowledge available for entrepreneurs going through this transition. The last barrier sees the market demand and the feasibility of the concept of a PaaS as a barrier to itself, making it a relevant barrier to be taken into account. To conclude, these barriers mentioned are of great significance and should be taken into consideration by companies going through the transition towards a service model as these barriers target the feasibility of the entire company directly.

ENABLERS IN COMPARISON WITH THEORY

The enablers given during the case study are shown in Table 6 as enablers. The enablers are mainly there to help the company overcome the barriers encountered during the transition. As the enabler is meant to help companies, they will not solve a specific barrier entirely. Therefore an enabler is seen as a tool to address the barriers holding back the transition.

In the next paragraph, the enablers of the case Mitsubishi are analysed by comparing it with the enablers found in theory.

FINANCIAL ENABLERS

The comparison between the Financial enablers of Mitsubishi and theory (See appendix C Table 26) shows a difference. The theory focusses around the financing structure and how to improve this to gain proper financing from an investor. As Mitsubishi is a big corporation, even including a bank in Japan, their approach is more focused on the calculation of the financial model and expanding the value created to gain proper financing. Also, as an existing company, Mitsubishi already has enough resource and income to pre-finance the PaaS development themselves before stepping to an investor. This luxury of enough resources diminishes the need to gain investments at the start when barriers such as lack of data are still present.

ORGANISATIONAL ENABLERS

The organisational enablers mentioned during the interview of the case of Mitsubishi are shown in appendix C Table 27. Looking at the enablers given by Mitsubishi, the enablers can be divided into external and internal orientated. The externally orientated enablers being; talk and offer PaaS options, Marketing, Contract external partners, do not push the companies believes onto a possible partner, and find a prominent developer to kick start the PaaS product. The external-orientated enablers are focused on creating partnerships that will establish the company within the supply chain. The internal-orientated enablers are; Educate and/or replace staff, and point out an employee to promote and manage the PaaS product. Compared to the theory which focusses on the four levels of the organisational change framework, the case of Mitsubishi looks more at the supply chain and the individual. This focus is possible since Mitsubishi is already a manufacturer of elevators and is less influenced by the supply chain.

LEGAL ENABLERS

Looking at the Legal enablers Appendix C Table 28, there are some differences. The enablers from theory are about the form of the contract, which can create a specific legal structure around the PaaS product. The enablers from Mitsubishi are more in-depth on how to make the contract. The enabler of "research with an external notary and legal consultancy" and "create a contract based on KPI's" are ways of giving the contract a foundation which works for the specific PaaS product. Though creating, using and validating the contract can only be done, if first is decided which legal structure the company will use. Therefore, the theory's enablers are focused on

the general structure of the contract, and the enablers from the case study are more in-depth to validate and adjust the contract to fit the company and PaaS product. So, the enablers given on both sides have a different focus and can be used together to overcome legal barriers.

OTHER ENABLERS

Seeing the other enablers given by the case study of Mitsubishi, there are some interesting enablers to be mentioned. First, their ways to market and their first steps when creating a fully functioning company/product. The enablers of creating attention by using a case such as the Circle of ABN AMRO have given the PaaS product much attention in the media and other developers/investors. Also, by replying to every question regarding their products, with an M-use offer even though the client did not ask for this. The second step for Mitsubishi was finding a developer/project where they were able to deliver multiple products, and with that, creating demand high enough for continuous production. During these first steps, they acknowledged that not every part is perfect yet, and with small steps, they tried to improve the PaaS product.

4.1.2 SIGNIFY

Signify is a company of Philips, which provides lighting and light-as-a-service for B2B and B2C markets. Signify is a world leader in lighting for professionals, consumers and has a strong interest in lighting for the Internet of Things. They focus on delivering energy-efficient products, systems and services. The service provided by Signify called Lighting-as-a-service is offered in multiple variants, therefore creating various value propositions each focussed on different customer(s) (segments).

BARRIERS AND ENABLERS OVERVIEW

The interview output regarding the business of Signify's Lighting-as-a-Service have been visualised (See appendix D Table 29). In the next overview (see Table 7), the same barriers and enablers are pictured according to the main categories; Finance, Legal, Organisation and Other.

Barriers			
Finance	**Legal**	**Organisation**	**Other**
Other ways of financing for each client needed	New contract form is needed	New unfamiliar stakeholder involved	The product needs to be able to evolve over time (especially layers with 10+ years lifespan)
End of life calculation is important		Favour of multiple stakeholders is needed	Competition for the product is big (for the service not yet)
Own resources are limited, financing is needed		New way in market	
Getting in touch with financier is difficult		Multiple departments and expertises are needed	
Financing though external companies is costly not profitable		More expertise is needed than the company has	
Paying for the service is a deal breaker		Multiple departments need to be managed and work together	
Create multiple value propositions per segment		Multiple expertise is needed on financial, marketing, logistics, legal and organisational	
		Providing services is not companies key activity	
		Getting in touch with key partners is difficult	
		PaaS awareness is limited	
		Every segment has it own demands/needs	
		Different go to markets, with different strategies needed	
Enablers			
Finance	**Legal**	**Organisation**	**Other**
Determine financial value of product (and show as reduction on financing to customer)		Have multiple offerings of the service delivered (service, circular or amount saved)	Each stakeholder needs to gain something
Use financial experts in-house to create a relationship with a financier		Be the director of the logistics of the departments	
Use the banks skills of risk analysis on clients		Do not try to have all the expertise in-house	
See the external financing not as income but as an extra service provided		Find key partners to do key activities	
Offer multiple options of financing and service providing		Search for partners to support key activities	
		Create awareness with marketing on different levels	
		Use old clients to promote new service	
		Focus on 1 or 2 go to markets	
		To beat the competition have fair prices on the product, and create extra value in the service	

Table 7. Overview of Signify's barriers and enablers according to the main categories. (own illustration)

BARRIERS IN COMPARISON WITH THEORY

A comparison with theory from the literature study is made to analyse the data received from the interview with Signify. First, the barriers and the difference are examined. Secondly, the enablers are compared, after which conclusions are drawn about the similarities and the differences.

FINANCIAL BARRIERS

The financial barriers seen in appendix D Table 30 differ from each other, as most of the Signify's barriers are mentioning the importance or difficulty of the financial side of the PaaS BM. In contrast, the theory barriers mention the underlying cause, which causes the problem of gaining finance for a PaaS BM.

Looking at the Signify barriers, there are three main points made; the difficulty of external financing, the costs of a PaaS product and the different value propositions. The difficulty of external financing lays within; the difficulty of reaching out to the right partner, the interest on loan makes external financing not profitable, and own resources are limited, so financing is needed. These are the reason given by Signify, though the barriers provided by theory do not say precisely the same, they do support it. As the lack of data shows a higher risk on loan, the interest goes up, and the less financial partners are willing to invest in the company. Also, things as cash-flow problems make it difficult for parties with their own limited resources to invest in their PaaS product. The barriers of the theory also mention the higher costs of a PaaS product compared to a traditional product for sale, as there are low virgin material prices and the service offered gives higher costs on the long term. Therefore, the barriers provided by the case are supported by the barriers given in the theory and have a direct relation of cause and effect.

LEGAL BARRIERS

The barriers of the Legal perspective given by Signify compared to theory, provide a rather unusual sight. As seen in Appendix D Table 31, only one barrier is mentioned by Signify. The barrier "new contract form is needed" shows the problem every PaaS providing company comes across as the contract is non-existing yet, and is the enabler to exclude various risks, such as retaining ownership or the client defaulting on the deal and service provided.

ORGANISATIONAL BARRIERS

Looking at the organisational barriers (Appendix D Table 32) given by Signify, the organisational framework of change provided in chapter 2 is used again. The framework consists of 4 levels; big picture, company, department and individual. The barriers given by Signify first mention the partners and stakeholders involved in this new process, which can be seen as the barrier in the level of the company/supply chain. The following barriers are focussed on the departments needed within the company and which expertise they should have. This can be seen as barriers within the level of the department. The last few barriers are focused on the market and the different client segments. These are barriers that do not entirely focus on the individual, but instead see a client segment as the categorisation of an individual. Concluded can be that three levels of the change framework have been mentioned by Signify, though the fourth level of the bigger picture is not mentioned the framework also points out that this is something outside of a company's influence. The individual's level is mentioned by Signify through segmentation of individuals and is only focused on the client. The individual-level focused on the employees is done by segmentation into departments and is therefore seen in the Department's level rather than in the level of the Individual.

OTHER BARRIERS

There is only one barrier in the category Other given by Signify. As the category Other was not explicitly asked for, this is not strange. Barriers and enablers given in this category help to further understand the barriers seen per case, but do not necessarily answer the main research question. The barrier mentions the role of stakeholders, of whom each requires something from the company. As stakeholders need to be persuaded to follow/help the PaaS product replace traditional products, they need to be given enough reason to do so. Therefore each stakeholder needs to gain something, which can be seen as a barrier as this is not done easily.

ENABLERS IN COMPARISON WITH THEORY

In Table 7 the overview of the enablers of the Signify case is presented. In the next paragraph, the enablers of the case Signify are presented and analysed by comparing the enablers to theory.

FINANCIAL ENABLERS

The financial enablers seen in Table 33 in Appendix D are given by Signify during the interview. The enablers provided by Signify are an addition to the enablers given by theory. As the enablers of theory go in-depth on procuring much-needed loans for acceptable interest payments, the enablers of Signify are more about the financial value of the product and the value of the financier. A financial expert needed to gain a relationship with the financier, and the in house knowledge of the financier on risk analysis can be used to the companies benefit. Signify's enabler of offering multiple different financing methods to their client enables them to meet diverse client needs. The options of selling, leasing and pay-per-lux are different payments, each having other benefits for the client, enables them to attract more customers. Though different payment structures require various contracts and different approaches, having multiple options based on the PaaS concepts enables Signify to sell more and gain a more significant market share.

LEGAL ENABLERS

The legal enablers given by Signify (see Table 34) are like the legal barriers limited. This, due to being a PaaS product that is easier removed (from the ceiling), imposes less legal barriers. Therefore fewer enablers are needed to overcome the legal barriers. The enabler mentioned by Signify is the use of KPI's as a base for a PaaS contract, with the help of KPI's, the product can be better visualised and monitored, and the contract is also easily changed.

ORGANISATIONAL ENABLERS

Looking at the Organisational enablers of theory (appendix D Table 35), the organisation change framework's four levels are visible. The enablers given by Signify are, on the other hand, only focused on the partners and clients. Signify has concentrated on the multiple offerings of the service delivered and key partners to help provide this to the clients. The enablers can be divided over two levels; supply chain and the department, this because the enablers related to the bigger picture and the individual level are left out. The main point made by Signify is the offering of multiple services; by doing so, they spread their income and risks over various offerings.

4.1.3 CHAINABLE

Chainable is a company which started recently with offering the service of a Kitchen-as-a-Service, otherwise called KaaS. In the year 2020, chainable has introduced a kitchen-as-a-service concept and is now ready to deliver the first products. With the kitchen of Chainable, the company offers a circular kitchen with reusable materials and energy-efficient equipment. The offer is specially made for housing corporations and institutional investors, who are developing sizable housing projects in the Netherlands. With multiple variations on the value proposition, chainable is ready to take on the market in the coming years.

BARRIERS AND ENABLERS OVERVIEW

During the interview held with the general director of Chainable, the following barriers and enablers were identified (See appendix E Table 36). In Table 8, the overview of barriers and enablers is made by categorising it according to the four main categories: Finance, Organisation, Legal and Other.

Barriers			
Finance	**Legal**	**Organisation**	**Other**
pre-finance is difficult, especially the first initial investment of start-up	Legal ownership is hard to define	Different demands from the market	Other parts by key partners are not designed with circular or sustainable principles
Due to a long payback period and cashflow based income, finding financier is difficult	Bouwbesluit sees product as part of building	connection of the product with sewerage, electricity etcetera are not within expertise or key activities	
PaaS is more expensive than just the product		As a start-up, you need to grow with the company and sales	
Costs of service are hard to determine		Key partners must take back parts, for the circularity of the product	
		Consumer have too many demands	
		Which market position are you going to take	
		the traditional market is filled by long-existing companies with existing client relations	
		current channels within the traditional market are dominant and hard to overtake	
		Trying to explain the added value of PaaS is difficult	
		Information details of parts are sensitive and not easily shared by partners	
		Good PaaS concept needs to grow exponentially, otherwise will be copied by others	
Enablers			
Finance	**Legal**	**Organisation**	**Other**
find a private financier for first starting capital	Create a ground lease construction for the product with the notary	Start with interviews to find demands/problems in the market --> adjust value proposition to it	Support key partners with their obstacles

Find alternative income as a guarantee for payback loan. (per 2 full As-a-service, sell one regular product (with service))	Incorporate all Legal barriers in contract	buy-back proposition to keep track of circularity of product parts	The cold acquisition should be done through a research perspective rather than a commercial perspective (talk with the client about the circular product and ask how it can fit their needs)
Corporations have enough money to pre-finance the product themselves	Create a suspension point for the product, which the client rents out to the company	buy-back agreement for both parties (amount can be decided already for extra encouragement)	
	Test all legal options to see the barriers and enablers per option (multiple pilots)	Think ahead of activities which will grow with company sales, make them flexible to grow along	
		Find a partner to help support growth	
		First sign an intention agreement with key partners, after that sign a collaboration agreement.	
		Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)	
		Having experts from traditional product-market can be a selling point to clients	
		A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation	
		know that you want to change the market, not overtake the market (or beat components)	
		Explain according to the cost of ownership (fewer repairs for example)	
		Explain the benefits of usership --> ergonomics value or value of achieving circular goals	
		Have low margins and a more extended payback period to conquer the market	
		Go along with the CE movement for the company to grow	

Table 8. Overview of Chainable's barriers and enablers according to the main categories. (own illustration)

BARRIERS IN COMPARISON WITH THEORY

A comparison with theory from literature study is made, to analyse the data received from the interview with Chainable. First, the barriers and differences are looked at. Secondly, the enablers are compared, after which conclusions are drawn about the similarities and the differences.

FINANCIAL BARRIERS

The comparison of the barriers (appendix E Table 37) seen in theory with the case of Chainable shows some differences and comparisons. First, all of the barriers of Chainable are mentioned by the barriers of theory. Secondly, the barrier of pre-financing and initial investment mentioned by Chainable are two different barriers mentioned in the literature study. Especially start-ups, such as Chainable, have limited own resources and therefore rely on external partners who can provide the investment needed to kick start the company. This is a barrier mentioned in the literature of Circular Business Models and is seen as a significant barrier in the theory of entrepreneurship. Thirdly, the barrier of the long payback period and the cashflow income of a PaaS business model is seen as a barrier both in theory and in the case of Chainable. As the barrier of a long payback period and cash flow-based income is a key characteristic, the barrier of "PaaS is more expensive than just the product" is seen both in theory and in the case studies. The barrier "costs of service are hard to determine" is seen by Chainable as a direct cause of the barrier "lack of data", as supply chain partners do not share data about their products/materials. Therefore the maintenance and repairs are hard to determine, making the costs of ownership and the service provided hard to calculate. As all of the barriers are also seen in theory, the difference is in the theoretical barriers not mentioned by Chainable. However, Chainable noted one other barrier, the lacking standardization. Chainable found this more a goal than a barrier, as standardization leads to circularity and should be strived for rather than solved.

LEGAL BARRIERS

Having the barriers of both theory and Chainabe next to each other in Appendix E Table 38, the barriers are analysed. Chainable's barriers are the same as in the other two cases and focus on the contract and legal structure to retain ownership and the obstructing laws that make retaining ownership difficult. As with most PaaS in the built environment, the bouwbesluit sees the PaaS as a vital part of the building and therefore claims that the ownership belongs to the building owner. This policy is made to protect a homeowner in a linear economy and is consequently obstructing the transition towards a circular economy. As this barrier involves policies, companies are not able to solve the barrier; they can only work around it. This way of working around the barrier of bouwbesluit is a difficulty on itself and therefore also seen as a barrier.

ORGANISATIONAL BARRIERS

In the comparison between Chainable and theory of the Organisational barriers, more difference than comparisons are found. The theoretical barriers are focussed on the company and the transformation of the BM during the transition towards a circular company. As a start-up, Chainable does not see these barriers, as they have the goal to be circular, and their company is built around the concept of PaaS. Therefore Chainable does not encounter barriers such as lack of support from senior management and hesitant company culture. Chainable has different barriers, such as getting into the market and finding a position. Also, the expected growth and the activities surrounding a PaaS product are seen as barriers that startups face. Though one barrier mentioned by both is the conservative industry and linear system, as the PaaS concept is still new to the market, this barrier will stay for the coming years. Though Chainable, as a startup, encounters different barriers, they barriers are still evenly spread over the four levels given by the organisational change framework.

OTHER BARRIERS

The extra barrier mentioned by Chainable is just one thing. Chainable mentions that circular or sustainable principles are not found in the supply chain quickly and therefore, guaranteeing the 100% circularity of a PaaS is not easy.

ENABLERS IN COMPARISON WITH THEORY

The enablers given during the case study are shown in Table 8. The enablers help the company overcome the barriers encountered during the transition. As they help to overcome, they do not solve a specific barrier entirely. Therefore the enabler can only be used as input to help overcome barriers holding back the transition.

In the next paragraph, the enablers of the case Chainable are analysed by comparing it with the enablers found in theory.

FINANCIAL ENABLERS

The enablers given by Chainable (Table 40) are about procuring the first loan of the company. As a start-up, their focus is on finding alternative ways to gain a loan from an investor. As banks are not keen on investing in small starting companies without a proven concept, they are looking at different types of investors. Therefore two of the enablers are focused on alternative investors; housing corporations and private investors. The other enabler gives the option to create alternative income, making a guarantee that the company has a higher income to pay back the loan.

ORGANISATIONAL ENABLERS

The organisational enablers in Appendix E Table 41 are mainly focused on the supply chain and the company's internal growth. As a startup, Chainable is in the middle of creating meaningful relations with key partners such as the primary partner for the appliances in the kitchen and with potential clients such as housing corporations. Also, it is already looking forward, when key activities as maintenance are going to grow. For this, they are already setting up the company structure to grow with them, or if needed, they search for a partner who can help support the expected growth. The enablers are all focused on the long term of the company, and by having the long term in mind, they try to create a lasting relationship fruitful for both parties.

LEGAL ENABLERS

The comparison between theory and practice for the case of Chainable is visualized in appendix E Table 42. As the theory gives multiple options on creating a contract with the client to deliver the PaaS without losing ownership by looking at existing legal structures, Chainable has looked for new ways to make a contract. By creating a ground lease construction (recht van opstal), the company can rent the ground on which the PaaS is placed, therefore keeping ownership. A remark needs to be added that there are still some implications with this enabler as the tenant protection can make repossession difficult. The other way is by renting a suspension point on which the PaaS can be placed. Therefore the product itself can be offered as a service to the client. As Chainable has not decided on which legal structure they will continue, they mention testing is the best way to make sure that the most fitting system is chosen for them.

OTHER ENABLERS

Chainable has given two more enablers in the category Other, which can be seen inTable 8. The first is about helping their partners with their obstacles. If you want to make an impact on the industry, you need to help the people surrounding you as well. That is a lesson Chainable believes in as they want to change the market, beating the competition to make money is not their ambition. Second, the acquisition of a product should be transformed into a research/interview, a way to talk to possible clients and learn from them, rather than only try to sell the PaaS product.

4.2 SYNTHESISE RESULTS

In this paragraph, the output from the case studies and theory is synthesised. By looking at the barriers and enablers given throughout the research, duplicates are filtered out to create a complete overview of all the barriers and enablers. The most mentioned barriers can be seen as common or important barriers; the resulting overview has been concluded on. As the enablers are unique to the companies business plan, the duplicates are filtered out, but no conclusion is made on this overview.

4.2.1 SYNTHESISED BARRIERS

Looking at the barriers given during the case studies and theory, there are duplicates found. As the barriers mentioned more often tell something about the importance of the barrier, it is interesting to look at them. To see which barriers are mentioned more often, the data input from the case studies and theory are synthesised per category in the paragraph and visualized in the tables in Appendix F.

ORGANISATION

Looking at the barriers given during the case studies and theory, there are some mentioned multiple times. Out of the 20 barriers provided by the case studies and theory, 12 are mentioned twice or more, of which four are mentioned three or more times. The barrier "lacking expertise" is mentioned six times, which is the most a barrier is mentioned during this research. "Limited willingness to collaborate in the value chain" is mentioned five times and "Lacking consumer awareness and interest" is mentioned four times. Making this the three barriers mentioned the most and therefore, the most encountered barriers within the category of Organisation.

FINANCE

Seeing the barriers mentioned in the category Finance in Appendix F Table 44, there are 17 barriers in total. Of these 17 barriers seven are mentioned twice. Two of them are mentioned three times; there is no barrier mentioned more. The barrier mentioned three times are "Difficulty defining which party pre-finances" & "Service is more expensive on the long term then buying".

LEGAL

The legal barriers seen in Appendix F Table 45 show a different picture than the barriers in the category of Organisation and Finance. First of all, the number of barriers is less, which is ten barriers than the 20 and 17 of Organisation and Finance. Secondly, there are only three barriers mentioned twice or more by the case studies and theory. This can be explained by the difference of a PaaS product offered by the case studies and analysed by theory. Also, the different lifespan and connection to the building affect the service and risk of a company. Therefore each case study might encounter different barriers. Though it also explains why one barrier is mentioned three times, which is the barrier "New contract form is needed". This is as PaaS contracts are non-existing; it also needs to be formulated according to the service and product delivered and the risks involved in the process, making this the most common and most important barrier for each case.

OTHER

The barriers in the category Other (See Appendix F Table 46) are special, this as they are not researched in the theory part, and therefore already have less chance of being mentioned twice. Secondly, these are the barriers which each specific case study encountered on their way to transition towards a service model. Therefore each barrier is specific per case and duplicates are not found. Though each barrier is explicitly mentioned by the company and seen as an essential barrier for themselves, it does not mean other companies will encounter them as well as they might be product/service specific.

CONCLUSION

Looking at the barriers given during the case studies and theory, there are some mentioned multiple times. Seeing which barriers are mentioned more often shows the importance of the barriers. The importance of a barrier which is mentioned more than once is due to the reason why it has been mentioned more often. The reason why a barrier is mentioned more often can be because of two reasons. The first reason is that the barrier input comes from multiple sources, each source can mention the same barrier and, therefore, show the barrier's importance, as each case study or theory came across the same barrier. The second reason is that the case studies had to explain the barriers according to the business model canvas; therefore, mentioning a barrier twice in a case studies implies that the barrier is seen throughout the business model canvas and affects multiple parts of it. Consequently, it can be said that the barrier, which is mentioned more than once according to the BMC has a more significant influence on the company than a barrier which is mentioned just once. The barriers given for the category Legal and Other are more product/service specific. Therefore duplicates are almost none existing, though it does not mean that they are not less important for any other company. The barriers which are mentioned multiple times are shown in Appendix F Table 43 to 46.

4.2.2 SYNTHESISED ENABLERS

ORGANISATION

The organisational enablers presented in Appendix G Table 47 show 33 enablers, of which 9 have a duplicate. This is the most extended list of barriers or enablers mentioned in this research. As the organisation category embraces most of the aspects of the BMC, this was expected. Though fewer enablers are mentioned twice, and only two enablers are mentioned three or four times. The enabler EO14 "Have multiple offerings of the service delivered" is mentioned the most as all of the case studies are currently using this in their business plan. Barrier "Have awareness campaigns" is with 3 mentions the number two on the list with most mentions.

FINANCE

Table 48 in Appendix G showing the overview of Finance enablers is consisting of 18 enablers of which one is mentioned three times. The rest of the enablers is mentioned only once. The enabler EF7 "Use up-and downstream partners to gain collaborative chain financing" show the importance of the supply chain, not just for the product lifecycle but also for the financial statement of the company itself.

LEGAL

The legal overview of enablers (Appendix G Table 49) shows two duplicates within 12 enablers. Both are targeting the creation of the service contract. The enabler mentioned twice is "Use KPI's to create a contract" and the enabler mentioned three times is "contract making, using, changing, validating"

OTHER

The overview of other enablers has no duplicates and a total of 8 enablers. Each being specific for the company of the case studies just as the barriers.

CONCLUSION

The enablers given by theory and practice show fewer duplicates than the barriers. This can be explained based on the specificity of the enablers offered by the case studies. The enablers given during the case studies are mainly product-specific and therefore not seen in the other cases. Resulting in a more diverse selection of enablers and fewer duplicates.

4.3 RELATION BETWEEN BARRIER AND ENABLER

To create an overview of the barriers and enablers the synthesised tables from the paragraphs before are used to create a list. With the overview of all the barriers and enablers, a cross table shows the relation between barrier and enabler. A relation is shown when the enabler helps overcome the barrier, an enabler can help overcome multiple barriers, and the barrier can be overcome with the help of multiple enablers. To see which enabler has the most potential an analysis is done per cross table in the section below.

ORGANISATION

The synthesised barriers and enablers of the category organisation are shown in Appendix H table 39. In Table 9, each barrier is connected to the enablers that can help overcome that barrier. Looking at the cross table, there are three barriers connected to more enablers than the other barriers. These are barriers OB1 "hesitant company culture", OB6 "Lack of support from senior management" and OB18 "As a start-up, you need to grow with the company and sales", these barriers can be easier overcome with the help of various enablers. The other barriers connected to multiple enablers are OB3 "Lacking consumer awareness and interest" and OB4 "Operating in a linear system".

The enablers showed in the overview help overcome up to six barriers at the same time. The enablers OE 3, 8, 10, 12, 15, 16, 19, 25, 26, 27 & 29 are solving four barriers or more per enabler and are therefore seen as the most significant enablers within this overview. Enabler EO19 "Focus on 1 or 2 go-to markets" has six barriers and is the most efficient enabler of the category Organisation. The organisational enablers have one enabler that does not connect with the barriers given in the overview. This is enabler EO11 "Design using a systems perspective to capture more value in products lifecycles". The enabler focusses on an organisational process that helps create value in the product. However, as the word value already mentions this enabler helps with a financial statement and therefore can help overcome barriers within the category Finance.

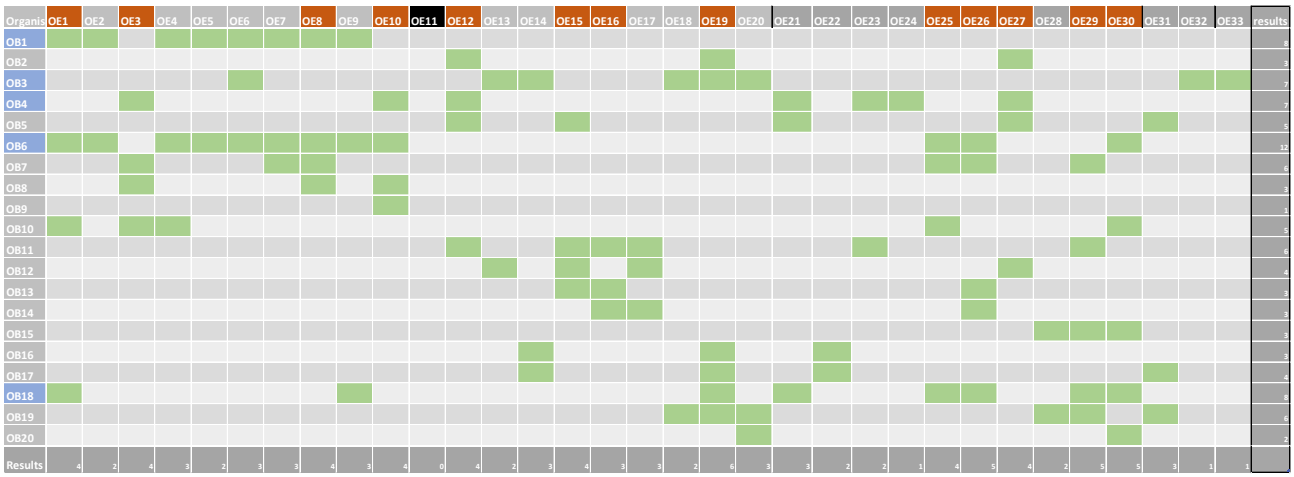

Table 9. Relation between Organisational barriers and enablers. (own illustration)

FINANCE

Seeing the overview of the barriers and enablers presented in table 41 and the relations between them in Table 10, a few conclusions are drawn. Out of the 17 barriers, six barriers seem to be overcome by various enablers. These barriers have between five and eight enablers dealing with the barrier. The barrier which has eight enablers connected is BF8 "High investment risk due to long lease period ". There are two barriers in this category that have no relation with the enablers presented in this research. These are barriers BF 1 "Low virgin material prices" and BF13 "calculate end value and how to enlarge it", which are focused around the outside market and therefore difficult to influence. These barriers are consequently dependent on external factors and not easily overcome by addressing the barrier directly.

There are seven enablers which address four or five barriers at the same time. These enablers are therefore seen as the most effective for the category of Finance. The enablers EF3 "use your product as collateral as a basis for a loan if the product is easily (re)moved" and EF16 "find a private financier for first starting capital" address four barriers by themselves, the enablers EF4 "For existing companies, use your past relationship to create trust", EF5 "Use public finance to close gaps in your balance sheets", EF7 "Use up- and downstream partners to gain collaborative chain financing", EF10 "Contract with financier" & EF15 "Offer multiple options of financing and service providing " address five barriers at the same time, making them the most effective. There is one enabler which is not connected to any of the barriers, this is enabler EF9 "Fiscal research and calculate". However, given by Mitsubishi, the enabler is more a general requirement to see the product's value and is therefore not seen as an enabler given to overcome barriers.

Finance	EF1	EF2	EF3	EF4	EF5	EF6	EF7	EF8	EF9	EF10	EF11	EF12	EF13	EF14	EF15	EF16	EF17	EF18	Results
BF1																			0
BF2											■								1
BF3		■	■		■					■					■	■		■	6
BF4		■			■		■			■		■						■	5
BF5				■			■												2
BF6	■		■		■					■							■		5
BF7	■				■		■			■						■		■	5
BF8			■	■		■	■	■					■	■			■		8
BF9															■				1
BF10																			0
BF11	■	■	■		■		■			■						■		■	7
BF12				■							■	■				■			4
BF13																			0
BF14				■															1
BF15				■							■	■							3
BF16						■								■				■	2
BF17															■				1
Results	3	3	4	5	5	2	5	1	0	5	3	3	1	2	3	4	2	5	

Table 10. Relation between Financial barriers and enablers. (own illustration)

LEGAL

The legal barriers and enablers seen in the overview (Appendix H Table 53) are related. This relation is seen in Table 11. Of the eleven barriers, BL 6 "New contract form is needed", can be overcome by the help of 7 enablers given in this research and BL7 "Retaining ownership" is overcome by five enablers. Two barriers, BL 3 "Lacking global consensus" & BL4 "Taxing system", do not have an enabler to help overcome the barrier. Like the finance barriers without enablers, these barriers are barriers involving external factors such as policies that can not be overcome by the company itself. Though an enabler is not provided to help overcome these barriers, it is good to know which barriers a company can encounter, even though they can not overcome them.

The enablers regarding Legal have five interesting enablers, being EL 6, 8, 9, 10 & 11. These enablers individually deal with three barriers, which is 25% of the barrier given in the category Legal. Enabler EL8 "contract making, using, changing, validating" deals with the most barriers, being four. All of these enablers focus on creating the contract, which is the most mentioned barrier in the category Legal according to paragraph 5.1.

Legal	EL1	EL2	EL3	EL4	EL5	EL6	EL7	EL8	EL9	EL10	EL11	EL12	Results
BL1								■					1
BL2						■			■		■		3
BL3													0
BL4													0
BL5						■			■		■		3
BL6	■	■	■		■			■		■		■	7
BL7	■	■	■						■		■		5
BL8				■			■			■			3
BL9					■		■	■					3
BL10						■		■		■			3
Results	2	2	2	1	2	3	2	4	3	3	3	1	

Table 11. Relation between Legal barriers and enablers. (own illustration)

OTHER

The barriers and enablers are shown in Appendix H Table 54 and the relation between them in Table 12. There is one barrier without enablers within the seven barriers, and two barriers with three or four enablers to overcome them. The barrier which is not connected to enablers is Bo3 "No knowledge of service being provided". The two barriers with the most relations to the enablers are Bo2 "Some segments are just not a fit" and Bo4 "No market demand yet". The number of enablers overcoming the barriers seems small, but respectively it is 30 to 50 per cent of all the enablers in the category Other, which makes the barriers easily overcome.

Each enabler has at least one barrier, and four out of these enablers have a second or third barrier they address. The two enablers connected to two barriers are enablers Eo1 "Add intelligence (sensors), new maintenance approach" and Eo4 "Create attention by going to exhibitions, lectures, or use pilot projects as an example". The most efficient enablers of the category Other are Eo7 "The cold acquisition should be done through a research perspective rather than a commercial perspective (talk with the client about the circular product and ask how it can fit their needs)" and Eo8 "Support key partners with their obstacles". As the category Other is not focused around one theme, all the barriers during case studies are different, and most have just one enabler. As they are not focused around one theme, the likelihood of a specific enabler addressing multiple barriers is therefore small.

Other	Eo1	Eo2	Eo3	Eo4	Eo5	Eo6	Eo7	Eo8	results
Bo1									2
Bo2									4
Bo3									0
Bo4									3
Bo5									2
Bo6									2
Bo7									1
results	2	1	1	2	1	1	3	3	

Table 12. The relation between Other barriers and enablers. (own illustration)

CONCLUSION

To conclude on paragraphs 5.1, 5.2 & 5.3, an overview of the most common barriers and most effective enablers is made. The most common barriers are deducted from the number of mentions during the research. Therefore the duplicates analysed in paragraph 5.1 are used to create an overview. The most important enablers are found by looking at the effectivity of an enabler. Consequently, the table overviews given in paragraph 4.3 are used to deduct the effectiveness by looking at the number of relations the enabler has with barriers.

4.4 VALIDATION OF BARRIERS AND ENABLERS

The most common barriers concluded on in paragraph 4.2, and the most effective enablers concluded on in paragraph 4.3 are validated through expert interviews with the companies from the case studies. By ranking the barriers and enablers per category, the overview is further expanded with the opinion of experts. The ranking is done by placing the barriers or enablers in order from most important to less. For the ranking from 1 to 10, the number one gets 10 points, and the number 10 gets one point. This is done for each category, and each interview and the points per barrier or enablers is summed up and divided by the number of interviews. The resulting average is the weight of the barrier or enabler, the highest weight is ranked number one, and the lowest weight is the last in the ranking.

ORGANISATION

The ranking within the category organisation shown in Appendix I Table 55, summarizes the barriers' ranking. The barrier chosen as number one is the barrier OB16 "every segment has its own demands/needs (need to be inventoried)". Combined with the number 2 barrier OB17 "different go to markets, with different strategies needed (which position in the market to take?)" they are the top 2 of the organisational barriers. Followed by three barriers from theory which suggest that the knowledge on PaaS is lacking and therefore are obstructing the transition towards a PaaS business. The top 5 is followed up by four barriers discussing the existing way of working in an environment that has been matured over the years according to the traditional way of buy-use-dispose. The last three barriers are on the linear system and the willingness of both company employees and supply chain partners to participate according to circular principles needed for a PaaS system. Seeing the barriers of the limited willingness and hesitant company culture on the last spots has been explained by the interviewees, the reason for creating a more circular BM is since they want to change the market. Changing a market entails that the market is not yet completely willing to change; therefore, this barrier is a given and also the reason to create a PaaS BM. As this is one of the main reasons to start a PaaS BM, this barrier is not perceived as a critical barrier that could stop them. The barriers of segmentation and market positioning are seen as most important as they are the most difficult and the most critical barriers that should be addressed in the making of the business plan. Changing an entire market needs to be done from a starting point carefully chosen, making it critical for the business's success.

The ranking of the enablers of the organisation category are shown in Appendix I Table 56. The number one enabler OE19 "Focus on 1 or 2 go-to markets" can be directly linked to the top 2 organisational barriers, as it enables a business plan to deal with the segmentation of the market. The rest of the enablers are all addressing different parts of the BMC and are therefore harder to categorise than the organisational barriers. The last two enablers are both ranked number last; these are enablers EO30 "Go along with the CE movement for the company to grow" and EO8 "Give employees function-specific training and training on change management and systems thinking". Both enablers are placed last due to the interviewees' main comment; this is a given thing each entrepreneur needs to do when starting a new innovative circular company. Chainable's additional statement is that enabler EO8 is less needed for startups, which can select their employees on entrepreneurial skills and motivation, unlike existing companies changing to a new BM.

FINANCE

The ranking of financial barriers is seen in Appendix I Table 57. The ranking of the eight barriers start with barrier BF6 "cash-flow problems" and ends with the barrier BF7 "difficulty defining which party pre-finances". The concept of a PaaS where the initial investment is not done by the buyer and is replaced by a regular payment for the product's offering is where the most significant problem lays. The need to find starting capital to produce and offer the product or service is where the barriers start. The following barriers are then found during the search for capital, starting with barrier BF13 "calculate end value and how to enlarge it". The other barriers, such as high investment risk and own limited resources, are making it hard for entrepreneurs to find a candidate willing to pre-finance. As the other barriers cause barrier BF7, the barrier is placed last on the list.

The ranking of financial enablers seen in Table 58 in Appendix I has enabler EF10 "contract with financier" on number one. Instead of the barriers that end with the concluding barrier, the enablers start with this. Number one of the enablers is; 'contract making with the financier", which should be the company's end goal to solve the barrier BF7 "difficulty defining which party pre-finances". The enablers after that come up with specific solutions to create a contract with the investor. Enablers such as; "find a private financier for the first investment" or "use public finance to close gaps in the balance sheet". Concluded can be that the ranking of barriers and enablers is turned around. As enablers are more product- or company-specific, they are less likely to end high on the ranking, as one interviewee can find it essential and the other irrelevant. Though the enabler EF10 is for each company relevant as capital needs to be created with the help of an investor.

LEGAL

The top 3 rankings of the legal barriers are seen in Appendix I Table 59. The ranking start with the barrier BL7 "Retaining ownership", followed by BL6 "new contract form is needed" and ends with BL5 "bouwbesluit". During the case studies, the barrier BL7 was already mentioned as the most crucial barrier, as the linear system is not made for products where the ownership is not transferred. As all systems are focussed on the transfer of ownership, this creates a massive obstacle for companies to solve. Making the contract the foremost tool to keep ownership of the product and minimise risks, though this contract form is not existing, it is the second most significant barrier to overcome. The last barrier of the bouwbesluit represents the obstructing laws that make the barrier of retaining ownership even harder than needed, as immovable objects are seen as part of the house and are therefore owned by the house owner. Due to this obstructing law, the ownership of certain products in the built environment is even harder to retain.

The legal enablers are ranked in Table 60 in Appendix I. The first enabler is EL10 "incorporate all Legal barriers in the contract, " which the interviewees see as an unobtainable goal. Still, it is seen as the most important enabler for a company. The following enablers focus on contract making or ways to circumvent obstructing laws concerning the retention of ownership. Just as the enablers in the categories finance and organisation, the product-specific enablers are placed after the more general enabler.

CONCLUSION ON RANKING OF BARRIERS AND ENABLERS

To conclude on the ranking of the barriers and enablers within the three categories, a few things should be mentioned. The ranking of the barriers per main category is focused on specific barriers first and the general barriers as last. As the general barrier is not easily solved and the way to solve it is by solving the small and individual barriers first, the ranking of those barriers is also low. The enablers are the other way around, as the most general enabler is put first. This since the product-specific barriers are not relevant for some companies, and therefore some are graded low. The main barriers are always placed in the middle, but the consistency throughout the validation makes the general enablers still come in front. This is compared to the product-specific enablers that are placed in the top part or placed last as it is not relevant for the company.

4.5 CONCLUSION ON THE RESULTS

Looking at the analysis and conclusions of paragraph 4.1 to 4.4 overall findings on the results is made. The main findings on barriers are formulated by comparing the ranking with the mentions and the input from theory. Also, for enablers, this is done by looking at the ranking, theory and amount of relations with barriers. In the following articles, the findings on the main categories of organisation, finance, legal and other are presented.

ORGANISATION

To conclude on the organisational barriers (Table 13), the ranking shows that six barriers are coming from theory (shown in bold letters) and six are not. The barriers from theory focus on the limited knowledge and the hesitation this unknown concept of PaaS brings along. Though from the interviews can be concluded that even though they are important barriers, the barriers are part of the choice of transitioning to a new innovative concept. Therefore these barriers are seen as evident and part of the reasoning to transition towards a service model. The other half of the theory barriers are more critical as they affect the market demand and the companies ability to design new products. Therefore this part of the theoretical barriers is placed higher in the ranking. The other barriers, which are not mentioned by theory, are more practical barriers that companies have encountered during their process of establishing a business plan. The mentions of the barriers compared to theory show that the theoretical barriers are more mentioned than the barriers of practice, though more mentions do not equal a higher ranking.

Rank	Mentioned	Code	Organisation barrier
1	3	**OB16**	Every segment has it own demands/needs (need to be inventoried)
1	2	**OB17**	Different go to markets, with different strategies needed (which position in the market to take?)
3	6	**OB7**	**Lacking expertise**
4	2	**OB5**	**Conservative industry**
5	4	**OB3**	**Lacking consumer awareness and interest**
5	2	**OB19**	the traditional market is filled by long-existing companies with existing client relations
7	2	**OB10**	Existing company changing into new way
8	2	**OB12**	New unfamiliar stakeholder involved
8	2	**OB14**	Providing certain services is not companies key activity
10	2	**OB4**	**Operating in a linear system**
11	5	**OB2**	**Limited willingness to collaborate in the value chain**
12	2	**OB1**	**Hesitant company culture**

Table 13. Final results of Organisational barriers. (own illustration)

Having combined the analysis and results from the organisational enablers in Table 14, conclusions on the organisational enablers are made. The enabler OE19 "Focus on 1 or 2 go-to markets" with the most connections to the barriers is on top of the ranking. Also, the enabler OE19 has a direct link with the top 2 barriers of organisation. So, the number one enabler is the most applicable and addresses the most critical barriers; thus, the placing on number one is understandable. The theoretical enablers are spread out through the ranking and make up for 33% of the total. This compared to 50% of theoretical barriers can be explained since enablers are more often product-specific and therefore are easier replaced by enablers from practice. The same as the theoretical barriers at the end of the ranking, the theoretical enablers have two that are seen as routine actions that should be undertaken in the transition to circular business plans.

Rank	relations	Code	Organisation enabler
1	6	OE19	Focus on 1 or 2 go-to markets
2	4	OE12	Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)
3	4	OE3	**Connect the circular approach to existing practices that contributes to a new circular model**
4	4	OE15	Be the director of the logistics of the departments
5	4	OE25	Think ahead of activities which will grow with company sales, make them flexible to grow along
6	5	OE26	Find a partner to help support growth
7	4	OE10	**Embed your circular methodology (deliverables, monitoring target) into day-to-day working**
8	5	OE29	A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation
9	4	OE27	First sign an intention agreement with key partners, after that sign a collaboration agreement.
9	3	OE16	Do not try to have all the expertise in-house
11	5	OE30	**Go along with the CE movement for the company to grow**
11	4	OE8	**Give employees function-specific trainings and training on change management and systems thinking.**

Table 14. Final results of Organisational enablers. (own illustration)

FINANCE

Looking at the final results of the financial barriers in Table 15, the following findings are summarized. The seven barriers seen in the ranking are comprised of six theoretical barriers and one barrier of practice. Though the barriers are mostly from the theory, they are no less important. The interviewees were all agreeing on the relevancy of all the barriers mentioned. Unlike the other rankings, there were not seen as irrelevant for their company. The barrier mentioned by practice, BF13 "calculate end value and how to enlarge it", is seen as the barrier that does not need to be solved to have a profitable business plan. Though solving this barrier would provide a considerable advantage for PaaS companies to gain proper financing; therefore, the barrier is placed high within the ranking.

Rank	Mentioned	Code	Finance barrier
1	2	BF6	**Cash-flow problems**
2	2	BF13	calculate end value and how to enlarge it
2	2	BF8	**High investment risk due to long lease period**
4	2	BF11	**limited own resources**
5	3	BF9	**Service is more expensive on long term than buying**
6	2	BF2	**lacking standardization**
7	3	BF7	**Difficulty defining which party pre-finances**

Table 15. Final results of Financial barriers. (own illustration)

The findings of the financial enablers given in Table 16 show an almost fifty-fifty division between theory and practice. Besides the equal division, also the ranking is split into two parts. The enablers obtained from practice are placed on top, and the enablers from theory are last. This as the theoretical barriers are more specific on financing structures and therefore less relevant for all the companies. The enablers obtained from practice are broader and are consequently placed higher in the ranking. The relation between the number of relations between the enabler and the barriers and the ranking is not significant.

Rank	Relations	Code	Finance enabler
1	**5**	**EF10**	Contract with financier
2	**5**	**EF18**	Corporations have enough money to pre-finance the product themselves
3	**4**	**EF16**	find a private financier for first starting capital
3	**5**	**EF4**	**For existing companies, use your past relationship to create trust**
3	**5**	**EF5**	**Use public finance to close gaps in your balance sheets**
6	**4**	**EF3**	**use your product as colleteral as basis for a loan if product is easily (re)moved**
6	**5**	**EF7**	**Use up- and downstream partners to gain collaborative chain financing**

Table 16. Final results of Financial enablers. (own illustration)

LEGAL

Table 17 contains the final result regarding the Legal barriers. The ranking of three barriers shows the order in which most interviewees address the legal structure of their business plan. First, the retaining of ownership is looked at, as this influences the contract form needed. The last barrier is the barrier BL5 "bouwbesluit" which entails laws and policies that are obstructing PaaS in the Dutch built environment. Still, as they are law and policies which are already being bypassed, the interviewees agree that it is not the most critical barrier.

Rank	Mentions	Code	Legal barrier
1	2	**BL7**	Retaining ownership
2	3	**BL6**	New contract form is needed
3	2	**BL5**	**Bouwbesluit**

Table 17. Final results of Legal barriers. (own illustration)

The ranking of Legal enablers shown in Table 18 contains no theoretical enablers, only enablers given during the case studies. The enablers consist of three general contract making enablers and two specific solutions on the legal structure to retain ownership. The more general enablers are placed on top, and the more specific are placed last. However, one specific solution enabler is placed above one general enabler. This being enabler EL11 "Create a suspension point for the product, which the client rents out to the company", which comes at the third place. The fact that a product-specific enabler is placed higher than a general enabler could point to an interesting enabler for companies to exploit.

Rank	Relations	Code	Legal enabler
1	**3**	**EL10**	Incorporate all Legal barriers in contract
2	**3**	**EL6**	Research with an external notary
2	**3**	**EL11**	Create a suspension point for the product, which the client rents out to the company
4	**4**	**EL8**	contract making, using, changing, validating
4	**3**	**EL9**	Create a ground lease construction for the product with the notary

Table 18. Final results of Legal enablers. (own illustration)

05

Findings

5. FINDINGS

In this chapter, the research findings are presented. The findings are discussed, and the application of the research outcome is presented.

5.1 RESEARCH FINDINGS

The results of chapter 4 helped to create a holistic overview of both barriers and enabler, provided by theory and practice. Based on the results of this overview, the research findings are summarized in this paragraph. The findings are focussed on the various overviews given in chapter 4 and the relation between them.

THEORY

Concluding on the literature, the literature reviews gathered from the literature have a multitude of perspectives and results. Firstly, the difference in perspectives is noticed in the main categories made by the leading researchers in the field of PaaS. By excluding categories, the importance of some barriers and enablers is implied, though sometimes not intended or not specified. Looking at the barriers or enablers specifically within a category, there are also numerous differences identified. For example, the barrier "lacking expertise" is not mentioned by Kirchherr et al. (2018), though the barrier is mentioned by multiple researchers giving it high importance (Eliasson & Johansson, 2018; Koukopoulou, 2020; Kuo et al., 2009). By trying to include as many barriers and enablers, without excluding any, a complete overview is made. The importance and applicability of barriers and enablers are disregarded on purpose during the creation of the overview, to create a complete and consistent overview and avoid any eliminations of barriers. Though by choosing three main categories, the scope of the research has been limited, which should be taken into account.

THE GENERAL APPROACH OF LITERATURE IN COMPARISON TO THE PRODUCT-SPECIFIC APPROACH OF PRACTICE

The comparison with theory and practice shows the difference in the way the barriers and enablers are approached. The literature on PaaS within the built environment is mostly focussed on the general influences of the PaaS BM, given this, the translation towards practice is mostly missing, making it hard for companies to translate the research findings into a business strategy. Research institutions, such as the Circle Economy, try to help by publishing company-specific research to show the practical implementation of the theory. Though, the lack of focus of the literature on specific products or supply chains, creates a missing link for companies. On the other hand, the implementations seen in practice by existing PaaS companies are mainly product-specific and hard to copy for other companies working with different products. By creating an overview where both practice and theory are combined, it is attempted to provide to future companies more context about the PaaS barriers and enablers. Future research should look more into the combination of theory and practice and find a balance between them.

THE RANKING BY PRACTICE GIVES MORE INSIGHT ON LITERATURE

With the expert interviews, giving a ranking to the barriers and enablers, the importance between barriers/enablers offers new insights. As current literature mainly suggest possible barriers and enablers, their importance is often omitted. However, exactly this relation between barriers/enablers gives future companies a valuable perspective when designing the business plan. For example, the barrier "Limited willingness to collaborate in the value chain" has been mentioned five times by practice and theory, showing that it is a barrier seen by most. Though it has been placed on the second last place during the ranking, with the comment made by interviewees, this barrier is normal for entrepreneurs and should not withhold a company from providing their service. However, it is still seen as a barrier, as it still provides a difficulty when making the first contact with possible supply chain partners. The ranking provides insights on the difficulty level of barriers or the effectiveness of enablers, giving future companies the input for prioritising during their business plan development.

5.2 APPLICATION OF RESEARCH OUTCOME

DEVELOPMENT OF THE BUSINESS PLAN

The overview given as the final result of this research provides future companies a perspective on the possibility of barriers and enablers identified within the Dutch built environment. The list of barriers can be used to identify possible barriers, which should be taken into account. The list of enablers gives the company a better understanding of possible strategies that can be included in the business plan. With the table showing relations between the barriers and enablers, the business plan can be aligned. Based on identifying the possible barriers and enablers, the company can prioritise their strategy according to the ranking given by experts. By doing so, the companies' focus can be well balanced. However, this research's output should be considered supportive and only used as input during the development of the business plan and not been copied into a final strategy of the companies business.

THE RANKING AND COMPARISON BETWEEN THEORY AND PRACTICE CAN BE USED FOR FURTHER UNDERSTANDING OF THE THEORY

Experts' ranking on the list of theoretical and practical barriers and enablers can be used for further understanding of the literature on PaaS. As the ranking provides experts' perspective in practice, the importance of barriers and enablers can be seen. With the barriers and enablers ordered into a ranking, the literature has gained an extra insight, and this insight can be used to determine the impact of the barrier or enabler. Companies can use the determined impact to address the importance of certain strategies and create an order in their approach certain problems.

06

Conclusion & Discussion

6. CONCLUSION & DISCUSSION

In this research, the PaaS concept implementation in the Dutch built environment is analysed by looking at the barriers and enablers. In this chapter, the conclusions on this analysis are given, using the main research question and four sub-questions defined in paragraph 1.4. First, the sub-questions are answered, followed by the main research question. Secondly, the limitations on the research are discussed and followed by recommendations on future application and research.

6.1 Research sub-questions

1 What is a Product-as-a-Service business model?

The concept of a Product-as-a-Service (PaaS), or Product-service-systems (PSS), is defined as the offering of a product, by selling the functional result rather than the object itself. By selling the product as a service, the ownership of the product does not transfer when purchased. In the current linear economy, a client normally buys a product and the ownership transfers and with it the end-responsibility of the maintenance and disposal. In a circular economy where a PaaS is implemented, the product's ownership will not transfer from supplier to client but will remain at the supplier's side and therefore also the responsibility to maintain and dispose of the product.

A business model is seen as a conceptual tool that allows to express a company's business logic. The business model contains a set of elements and the relations between them. With the set of elements, a description of the value of a company is presented. The business model canvas is a tool to visualize these elements and their relations. Transitions seen in the business models are called business model innovation, which looks at the implementation of new business models. This can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another.

Though, a PaaS is not considered a value proposition or business model. The PaaS is seen as a subsection of the business model, as a combination of the value proposition and revenue mechanism. Therefore, within the business model, there can be multiple PaaS, as it is a subsection of the whole business model. When looking at the different options within the spectrum of a PaaS, multiple categories can be made. According to Tukker & Tischner (2006), the PaaS can be divided into three main categories, each with their subcategories. The main categories are; product-orientated, use-orientated and result-orientated, which are shown with their related subcategories in Figure 5 on page 10.

To conclude, a PaaS business model can be defined as a business model which contains one or multiple PaaS value propositions with an integrated offering of products and services and has a revenue mechanism based on selling availability, usage or performance.

2 Which barriers are identified in the implementation of a PaaS business model in the Dutch built environment from a theoretical and practical perspective?

To create a complete overview of barriers identified in the implementation, both the theoretical and practical perspectives were taken into account.

For the theoretical perspective, literature reviews of leading experts in the field of PaaS were combined into one list. In total, 42 barriers were included in the list, containing barriers within the categories Finance, Legal and Organisation. However, some of the barriers were mentioned by multiple researchers; therefore, some barriers were mentioned twice or more. After filtering out the duplicates, an overview of 23 barriers was left. The division of barriers is as follows; nine barriers of Organisation, nine barriers of Finance and five barriers of Legal.

For the barriers identified by practice, interviews were held with three companies providing a PaaS within the Dutch built environment. Providing an extra 65 barriers for the complete overview of barriers, makes a total of 107 barriers mentioned in this research. Due to the similarities of the provided barriers both between cases studies and between case studies and theory, the duplicates are filtered out based on the entire list of barriers of both theory and practise. Resulting in a complete overview of 54 barriers spread over the main categories Finance, Legal and Organisation, with an extra category for "other" barriers. The final division of barriers is as follows; 20 barriers of Organisation, 17 barriers of Finance, 10 barriers of Legal and 7 barriers of Other.

Both the amount of barriers, as the number of times mentioned, is used as input for sub-questions 4. The complete overview is given in appendix F table 41 until 44.

3 Which enablers are identified to overcome the barriers when implementing a PaaS business model in the Dutch built environment from a theoretical and practical perspective?

The same approach for the identification of the barriers was taken for the identification of the enablers. However, a few differences in the theory are to be mentioned. For identification of the enablers within the theory perspective, the input of the theoretical barriers was used. The barriers identified were the basis on which the enablers were researched; therefore, the enablers given by theory directly relate to the barriers. Using this approach, the enablers provided in the literature review have no duplicates to be filtered out.

For the theoretical enablers, 24 were identified and placed in the overview. The division of enablers is as follows; thirteen barriers of Organisation, seven barriers of Finance and four barriers of Legal.

With the enablers identified by practice, an extra 62 enablers for the complete overview of barriers is provided, making a total of 86 enablers mentioned in this research. The duplicates are filtered out based on the entire list of enablers of both theory and practise. Resulting in a complete overview of 71 enablers spread over the main categories Finance, Legal and Organisation, with an extra category for "other" barriers. The final division of barriers is as follows; 33 enablers of Organisation, 18 enablers of Finance, 12 enablers of Legal and 8 enablers of Other. The amount of enablers after being synthesised has decreased less than the decrease in barriers after being synthesised. This can be explained due to the reason of having no duplicates in the literature section and the product-specific enablers given by the case studies.

As with the barriers, the number of enablers and the number of times mentioned are taken as input for sub-question 4. The complete overview is given in appendix G table 45 until 49.

4 Which barriers and enablers are the most important for the implementation of the PaaS business model in the Dutch built environment.

To answer the sub-question, the analysis of paragraph 4.1 to 4.4 needed to be combined. This includes the input gained from sub-questions 2 and 3. The number of times the barriers are mentioned are used to find the most common barriers to come with the list given to the experts to rank. As for the enablers, a list of the most effective enablers was made. With a list of the most common barriers and a list of the most effective enablers, the ranking on importance was done by experts. The complete overview of the ranking is given in appendix I table 53 to 58.

The most important barriers within the three main categories are according to experts;

- OB16 "Every segment has it own demands/needs (need to be inventoried)"
- BF6 "Cash-flow problems"
- BL7 "Retaining ownership"

The most important enablers within the three main categories are according to experts;

- OE19 "Focus on 1 or 2 go-to markets"
- EF10 "Contract with financier"
- EL10 "Incorporate all legal barriers in contract"

To conclude on the ranking of the barriers and enablers within the three categories, the following comments are worth mentioning. The barriers' ranking shows that (product-)specific barriers are placed higher than the general barriers. This can be explained, due to the solvability of the general barriers, which is higher than the specific barriers. The ranking of the enablers has the opposite, with general enablers first and product-specific enablers as last. As product-specific enablers focus on a specific object, most experts will not rank the enabler as important. Only the experts directly linked to product in question will rank such an enabler high on the level of importance. Therefore the average taken of multiple expert validations has placed the enablers low on the ranking.

Though the most important barrier and enabler per category are given as a direct answer on the sub-question, a remark should be made. Each company and each product has its own barriers and therefore its own enablers. Thus, the question and situation will vary for each company and cannot be answered with one answer. By giving a ranking and main conclusion on the importance of the barriers and enablers, an indication can be given for the companies.

6.2 MAIN RESEARCH QUESTION

As the construction sector needs to make a significant transition from a linear economy to a CE, entrepreneurs are now trying to implement the PaaS concept in the Dutch built environment. With a holistic overview, the implementation of the PaaS concept within the Dutch built environment can be stimulated. Therefore the research aimed to gather findings from both theory and practice on the barriers and enablers seen in the implementation of the PaaS BM in the Dutch built environment. The aim of the research was transformed into the main research question to give a conclusion on how to stimulate the implementation of the PaaS concept. The main research question formed in paragraph 1.4 was: **"HOW TO OVERCOME THE BARRIERS WITH RESPECT TO THE FINANCIAL, LEGAL AND ORGANISATIONAL ASPECTS OF IMPLEMENTING A PRODUCT-AS-A-SERVICE BUSINESS MODEL WITHIN THE DUTCH BUILT ENVIRONMENT?".** To answer the main research question, the results of the research and the four sub-questions is used.

Based on this research, two ways support the primary research aim. First, the identification of barriers, supported by the results in the literature review, paragraph 4.2 and paragraph 4.4. Secondly, the relation between barriers and enablers is supported by the literature review results, paragraph 4.3 and paragraph 4.4.

The identification of the barriers, through the main categories and both the theoretical and practical perspective, helps companies navigate the numerous findings given by various experts/researchers. The overview of synthesised barriers shown in paragraph 4.3, provides a complete overview for the companies to investigate. By synthesising the barriers and mentioning the number of times mentioned, companies already indicate how common a barrier is. With the addition of the ranking of the most common barriers, companies have a further understanding of the literature on PaaS. This understanding can be used in order to determine the impact of the barrier. Companies can use the determined impact to address the importance of specific strategies and create an ordered approach to certain problems. Stimulating the companies to overcome the barriers identified when implementing a PaaS business model.

The relation between barriers and enablers stimulates the implementation by suggesting possible enablers for the barriers identified in the process. With the overview given in paragraph 4.3 in Table 10 to 13 on page 47, the relationship between barriers and enablers is given. The overview of relations provides companies with possible actions to counter the barriers and shows the effect one enabler has on multiple barriers. Combined

with the ranking of the most effective enablers by experts, companies can develop their business strategy accordingly. Therefore, the relation stimulates the implementation by providing specific enablers to overcome the barriers identified.

To conclude on the main research question, first, the barrier should be identified, and secondly, the correct enabler should be chosen to overcome the barrier. Based on the various overviews provided in the research, companies have useful input to overcome the barriers with respect to financial, legal and organizational barriers identified when implementing a PaaS business model in the Dutch built environment. As concluded in sub-question 4, the input given is to be used as an indication and helps overcome the barriers, rather than completely solving it.

6.3 LIMITATIONS ON RESEARCH

The PaaS concept is broad, and due to time constraints on the research, it is impossible to incorporate everything. Therefore, the scope of the categories is limited to finance, legal and organisation. Elaboration on technology, for example, is excluded but should be considered in future research. Though the literature is still immature, there is progress in the research over the last years. Even within the limited scope of the PaaS concept, **the literature is rapidly expanding**. At the earlier stages of this thesis, barriers surrounding legal had almost no relating legal enablers. In the end, researchers of the TU Delft have come up with a legal structure that enables the service provider to retain ownership of a façade-as-a-service, enabling the company to deal with the most critical legal barrier identified by experts. Therefore, the rapidly expanding literature has a significant influence on the findings provided in this research and should be taken into account by the reader.

The amount of PaaS companies within the Dutch built environment are limited due to the selection criteria. The **limitations on companies** able to provide input for the research has had consequences for the research method and research output. The research methods are based on the input from practice and the validation of experts. As those have been the same, the bias in the expert validation is noticed by the researcher. Especially in the validation of the enablers, which are product-specific, the bias has undoubtedly taken place. The bias results from the fact that the same expert who provided certain product-specific enablers has to rank them as well. Through the average taken, the product-specific enablers placed high on the ranking by just one expert, is lowered by the other experts finding the enabler of less importance. With the average taken of each ranking by experts, the bias has been minimised. The research output is limited to the products and supply chains in which the case studies operate. Therefore the output from practice is less representable for the entire dutch built environment. Therefore the overview might be less applicable to companies active in different sectors than the case studies.

The transition of the Dutch built environment to a circular economy is not only done by manufacturers providing a PaaS. The **entire supply chain, developers and financiers, have to be taken into account**. As all the partners need to combine their efforts to be circular, every perspective should be researched when looking at barriers and enablers. In this research, only the service providers are taken into account, and the perspective of other partners is not included. Therefore, the list of barriers and enablers identified in the transition towards a CE are partial. The case studies used throughout the research are based on **two different types of PaaS companies**. One type is the company that already delivers the product and has transitioned towards a PaaS business model. According to the PaaS principles, the other type is a start-up that has started and based their entire business model. Both types sell PaaS offerings but encounter different barriers. Therefore it should be noted that the main research question has different outcomes for both types of companies. Though including both types in the literature review and case studies, the various overviews resulting from chapter 4 represent and stimulate both types.

To conclude on the limitations of the research, two main points should be taken into perspective. First, the literature on the PaaS concept and secondly, the case studies available and used.

The literature surrounding the PaaS concept is fastly expanding and entails a broad spectrum of PaaS types. As this research has created a scope to narrow down the research objective, the research findings are limited to this scope. Though a broad concept limited through a research scope, does not automatically mean that the findings are of less use. The scope helps the researcher to come with more specific findings, and therefore can be more accurate. The rapidly changing literature, on the other hand, should not be discarded. With more knowledge being accumulated each day by researchers and practitioners alike, the arguments used throughout this research could have become obsolete. Therefore literature dating from the start of 2020 should be considered when reading the paper.

The case studies at the moment of writing have been limited and therefore limit the research outcome. Though the limited amount PaaS companies, and the need for more, was one of the reasons for this research. Having a limited number of case studies has limited the overview of barriers and enablers, though the results are limited the findings made are not affected significantly. However, the few companies' limited results make the findings more applicable to the same type of companies. Therefore other types of companies might find the research outcome less useful, limiting this research's audience. The fact that the entire supply chain, developers and financiers are not considered within this research, is due to the research scope. Therefore, the research might be limited but not less valuable.

6.4 RECOMMENDATIONS

FUTURE APPLICATION

For future research, the application of the output provided in this research should be further developed. As the research output consists of multiple overviews, the readability for companies is difficult. The overviews can be combined by creating a structured framework, making it easier for companies to use. As some barriers and enablers are linked explicitly to start-ups, mature PaaS companies will not find them as relevant. Therefore, ordering the barriers and enablers according to the phases in which the company currently is, will help companies find the relevant barriers and enablers easier. Literature that could help create the framework might be found in the research topics of entrepreneurship or business model innovation, where the phases between a start-up and a mature company can be defined and linked to the barriers given in this research.

FUTURE RESEARCH

The recommendations are based on the limitations of this research and are given accordingly.

As in the Dutch built environment, more and more entrepreneurs are implementing a PaaS business model, future research into the practical perspective is recommended. The addition of more product-specific barriers and enablers help create a more substantial overview for future use.

Taking the perspective of all the actors involved in the implementation of a PaaS BM will further support the aim of stimulating the implementation within the Dutch built environment. With the focus of the research on the service providers, some critical actors are left out of the scope. It is further recommended to interview other actors and to combine their barriers and enablers to gain new insights on overcoming the barriers. Actors who should be included in further research are suppliers, developers & investors.

The research scope was limited; therefore, future research should incorporate different categories, such as technology. The broad concept of PaaS and the Dutch built environment's big industry still have multiple points of interest not yet researched. Trying to extend the output of this research by looking at technology and other categories is therefore recommended.

As suggested in the future application of the output, the consideration that two types of companies exist should be included in the research. Future research should define the different types of companies and adjust the overview of barriers and enablers accordingly.

07

Reflection

7. REFLECTION

Coming at the end of my graduation period, I can finally look back at my year full ups and downs. It has been a year where, due to corona, I was forced to graduate entirely online. Even though the entire process has been online, I have learned a lot. Conducting scientific research, Business models (BM), Product-as-a-service (PaaS) and conducting interviews, are just a few things that I have learned throughout this process.

In this reflection on my graduation, I will highlight a few topics. First, the research topic will be discussed in accordance with my study and faculty. Secondly, the research relevance is discussed and conclude on. Thirdly, the methods used in this research are reflected on. The last part of this reflection is from a personal perspective, looking back at the entire process.

RESEARCH TOPIC

Within the field of Architecture, Urbanism and Building Sciences, and the track Management in the Built Environment, this research is following the theme; design and construction management. The focus lays on the BM of a PaaS company within the Dutch built environment. This circular BM approach is a new way to help transition towards a CE of the built environment. By focusing on creating a holistic overview of the barriers and enablers identified when implementing a PaaS BM, the transition can be stimulated. Through this research, the circular ambitions of transitioning towards a CE within the Dutch built environment is stimulated. Therefore the chosen research topic is relevant for the field of architecture, urbanism and building sciences and in specifically for the theme of design and construction management of the track management in the built environment.

REFLECTION ON RELEVANCE

SOCIAL RELEVANCE

The implementation of the CE concept has high importance for both the economy and the environment in- and outside the built environment. As not only the economy and environment are affected by the CE concept, also the society, as a whole, is positively influenced. Therefore helping with the development of a strategy to implement the business model of PaaS in the built environment can improve the transition from a linear economy towards a CE. As both Dutch and European government have made the transition towards a CE a top priority on their agenda, this research might provide valuable insights into policies, regulations and legislation which influence this transition towards the CE. By providing companies with a clear overview of the barriers and enablers of both theory and practice, the literature on PaaS BMs becomes more relatable for practice. Furthermore, the most significant social contribution; this research paper provides and contributes to the CE concept which ensures a brighter future for future generations which will have the opportunity to use the same resources as our generation has.

SCIENTIFIC RELEVANCE

The application of the CE concept within the built environment is, according to researchers still in its infancy (Adams et al., 2017). Azcarate-Aguerre et al. (2018) have suggested that looking at innovative business models, different ownership scenario's and new ways of financing, support the transition towards a CE within the Dutch built environment. The current literature shows many barriers and drivers encountered in the transition towards a CE (Azcarate-Aguerre et al., 2018; Koukopoulou, 2020; Smeets, 2019), but further studies into bringing new business models into practice are still absent. Through the connection of the theory and practice perspective, a holistic overview is created, adding to the existing literature. With the addition of a ranking by experts, the understanding of the overview is also improved, as most overview lack information on the underlying relevance of each barrier or enablers.

The results of this research are also both socially and scientifically relevant to the façade branches. Because, the façade branches have recognized this research gap and have made a proposition towards the Dutch government to facilitate research into this (Zegelaar, 2018). Though this research is now being done (VMRG, 2019), still

more research is needed to facilitate the transition towards a fully CE within the construction sector. Therefore, the conclusions and recommendation made in this research can provide valuable and interesting insight for the façade branches to use in their transition towards a CE.

REFLECTION ON THE RESEARCH METHODS

LITERATURE REVIEW

The objective of the literature review was to gain knowledge on the research's main concepts: Product-as-a-service and business models, which would contribute to the main research scope. This is done by looking at a substantial amount of research and literature, by doing so, creating a better view on the scientific perspective surrounding PaaS in the built environment to write a first scope and main research question. Having done the literature review gave the researcher a clear goal to develop a problem statement on which could be further elaborated. The study itself went steadily with not too many delays. Though as a good overview was lacking in the literature, the overview of the research itself was also missing at some points in the process. Making this the difficulty during the first research part, but encountering and recognizing this difficulty also added depth in my problem statement, as it helped form the research aim of providing a holistic overview.

CASE STUDIES

In the second section of the research, the methodology of a limited case study has been used. It consists of 3 case studies where a small introduction of the cases is given, and according to a semi-structured interview, the data has been gathered. The case studies are used to gain a broader insight into the topic of PaaS and to see the perspective of the practice. The quantitative research method was used to add on the qualitative literature review and provide data for the creation of a holistic overview.

As there were limited case studies available in the Netherlands, only 3 cases were chosen. Also, a few differences were the result of the limited amount of cases, as there was a difference in the maturity of each case. The maturity was seen in the difference between Mitsubishi and the start-up Chainable, which were different companies. Though considering the results, this difference in maturity has a good effect on the completeness of the overview. Through the help of a framework (business model canvas), the semi-structured interviews were easily structured. Also, because the framework is known to the interviewees, they could go into depth without too many preparations or explanation during the interviews, making more time available for in-depth questions.

Reflecting on the interviewees, the same profile of the interviewees would have given the author a more streamlined output, or output at least from the same perspective and therefore easier to compare and analyse. Though the upside from having different perspectives is that the qualitative output gathered from the case studies, have a more broad view and support the holistic approach.

Overall, the cases studies have been the most interesting as the effect of the barriers and enablers were more described by the interviewees. The literature identified most of them, though the impact of them was not made clear by the literature. Therefore the case studies were an indication of the output which the expert interview would provide through ranking the barriers and enablers.

EVALUATION EXPERT INTERVIEWS

After compressing the list of barriers and enablers, expert interviews were done to rank them according to importance. The ranking of importance gave new insights into the barriers and enablers found throughout the research, which is at the end of your study still welcome to see. However, the fact that the expert ranking the barriers and enablers were the same experts who provided a part of them as well. Therefore bias was noticed during the interview, which was hard to respond on a young researcher sitting across an experienced practitioner. As a lesson should be concluded, that bias should be considered when creating the research

methods. By providing an average on the ranking this was partly solved, though, the limited amount of interviews has made this approach less effective.

OVERALL PROCESS (IN THE I WRITING FORM)

The overall process of this research has been with its ups and downs so far. This was partly by the changes made in the research questions by me in the beginning. Though after a lot of changing the main research questions has come out stronger and more precise. As I am thinking more than I am writing, the development of the paper has been slow at certain moments. The formal deadlines and the informal deadlines made by my mentors have pushed me to stay on track and not fall too far behind. Still, the discipline needed to write a thesis throughout this year, including the Covid pandemic, has been lacking at some moments in time. Looking back, there are, of course, things I want to have changed within my thesis and my study methods, but having learned from them, it can also be considered as a valuable lesson. I want to thank my mentors in particularly as they recognized my study habits early on, and tried to support me to be still able to create a scientific thesis.

08

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09
Appendix

APPENDIX A BARRIERS AND ENABLERS OF THEORY

Category	Barrier	Author		
Organisational	Hesitant company culture	Kirsscher	Eliasson	Kuo
	Limited willingness to collaborate in the value chain	Kirsscher	Eliasson	Eliasson
	Lacking consumer awareness and interest	Kirsscher	Kuo	Kuo
	Operating in a linear system	Kirsscher	koukopoulou	Eliasson
	Conservative industry	Eliasson	koukopoulou	
	lack of support from senior management	Kuo	Eliasson	
	Lacking expertise	Eliasson	Kuo	Kuo
	Lack of strategic planning	Kuo	Eliasson	
	Lack of an ideal management information system	Kuo		
Financial	Low virgin material prices	kirsscher		
	lacking standardization	kirsscher		
	High upfront investment costs	kirsscher	Koukopoulou	
	Limited funding for circular business models	kirsscher	Koukopoulou	
	Lack of data	kirsscher	Koukopoulou	
	Cash-flow problems	Koukopoulou		
	Difficulty defning which party pre-finances	Koukopoulou		
	High investment risk due to long lease period	Koukopoulou		
	Service is more expensive on long term then buying	Koukopoulou		
Legal	Limited circular procurement	kirsscher		
	Obstructing laws and regulations	kirsscher	koukopoulou	
	Lacking global consensus	kirsscher		
	Taxing system	koukopoulou		
	Bouwbesluit	koukopoulou		

Table 19. Overview of theoretical barriers. (own illustration)

Category	Enablers
Organisational	Make use of the organisational change framework
	Develop a compeling narrative to convince employees
	Connect circular approach to existing practises that contributes to new circular model
	Integrate circular ambitions in the company strategy
	Reinforce the message by senior managers or influencers and leaders within the company
	Use tangible examples for inside and outside the organisation
	Keep communicating simple and use common terminology within a variety of channels
	Give employees function-specific trainings and training on change management and systems thinking.
	Focus on building willengness to take an active role in the transformation of the company
	Embed your circular mehodology (deliverables, monitoring target) into day-to-day working
	Design using a systems perspective to capture more value in products lifecycles
	Control material flows by interface with up-/downstream partners
	Have awareness campaigns
Financial	For longterm projects create a project finance structure
	Use future cashflow prediction to gain a loan
	use your product as colleteral as basis for a loan if product is easily (re)moved
	For existing companies, use your past relationship to create trust
	Use public finance to close gaps in your balance sheets
	Use risk sharing mechanisms to brigde gap between perceived and actual credit risk
	Use up- and downstream partners to gain collaborative chain financing
Legal	Use a DBFM contract with pay back scheme
	Use a DBFM contract with transfer of ownership at end of contract
	Create a Circular Service Contract with ongoing service and no end date
	To mitigate risks opting out clausula's should be incorporated

Table 20. Overview of theoretical enablers. (own illustration)

APPENDIX B SEMI-STRUCTURED INTERVIEW

Date: _____

Name Interviewee: _____

Company: _____

Case/project: _____

CASE STUDY GOAL

To get insight in implemented strategies in order to overcome barriers regarding Finance, Legal and Organisation for Products-as-a-service in the Dutch built environment.

INTRODUCTIE

Geachte interviewee,

Allereerst, bedankt voor het deelnemen aan mijn onderzoek. Het doel van deze interview is het verkrijgen van data voor mijn afstudeeronderzoek aan de TU Delft. Met mijn onderzoek probeer ik products-as-a-service te analyseren die succesvol zijn binnen de Nederlandse gebouwde omgeving. Hiermee wil ik een ondersteunende tool creëren voor bedrijven die obstakels betreft financiën, juridisch en organisatorisch tegenkomen. Met deze ondersteunende tool wil ik bedrijven in de transitie naar een service model houvast geven en sturen richting mogelijke oplossingen.

Gedurende het interview zijn er geen foute of goede antwoorden op de vragen, dus wees vrij om je mening te delen. De resultaten zullen onherkenbaar en gegeneraliseerd worden weergegeven in mijn onderzoek. Het interview duurt ongeveer 40 tot 50 minuten. Indien goedgekeurd zou ik graag het interview op willen nemen voor verdere analyse na het afnemen van het interview.

Op de volgende pagina staan eerst wat algemene vragen betreft uw expertise en positie binnen het bedrijf. Daarna zullen de vragen worden gesteld aan de hand van het business model canvas. Aangezien de theorie achter het business model canvas misschien niet meer helder is voor u, heb ik op de laatste pagina een stukje theorie toegevoegd.

VRAGEN

Algemeen:

- Kunt u wat vertellen over uw rol in het bedrijf en uw rol ten opzichte van uw product-as-a-service?
- In enkele woorden, hoe zou u uw product omschrijven?
- Wat is uw achtergrond betreft expertise en onderwijs betreft circulariteit en products-as-a-service?

De volgende vragen zijn aan de hand van het businessmodel canvas (*onderaan het bestand is het businessmodel canvas te zien en kort beschreven*) beschreven en focussen zich op tegengekomen obstakels en de strategie om deze te overkomen.

Let op; Niet elk gedeelte van het businessmodel canvas hoeft te worden besproken, het is te gebruiken als tool voor het analyseren en onderverdelen van het gehele product.

Value propositions

- Zijn er obstakels geweest rondom de value proposition gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Key activities

- Zijn er obstakels geweest rondom de key activities gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Key resources

- Zijn er obstakels geweest rondom de key resources gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Key partners

- Zijn er obstakels geweest rondom de key partners gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Customers segments

- Zijn er obstakels geweest rondom de customer segments gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Customer relationships

- Zijn er obstakels geweest rondom de customer relationship gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Channels

- Zijn er obstakels geweest rondom de channels gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Cost structure

- Zijn er obstakels geweest rondom de uitgaven gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

Revenue streams

- Zijn er obstakels geweest rondom de inkomsten structuur gedurende de start van uw product?
  Zo ja;
  - Kunt u beschrijven wat dit voor obstakel was?
  - Hoe bent u omgegaan met dit obstakel?
  - Kunt u zeggen of deze aanpak effectief is gebleken?

APPENDIX C CASE ANALYSIS MITSUBISHI

Mitsubishi elavator-as-a-service		
	Barriers	Enablers
Value proposition	Way of pre-finance	Validate financial model, contract with financier
	VAT extention on product	Fiscal research and calculate
	Retaining ownership	Research with external laywer (notaris?)
	New contract needed	Create new contract with KPI
	Risk of early contract ending	Risk inventory
	Conservative environment	Talk and offer circular PaaS option
	How to implement longer lifespan	Add intelligence (sensors), new maintenance approach
Key activities	No known contracts in market	Invest, find new expertise people, talk with clients about contract forming
	Too much due dilligence on contract	Optimise by doing, true value analyse
	Existing company changing into new way	
	Little PaaS thinking	A lot of marketing
Key resources	limited own resources	Contract with financier
	Limited knowledge on PaaS of staff	Educate/replace staff
Key partners	Not having expertise inhouse	Create contract with external partner
	Not in DNA	Educate/replace staff
	Staff doesn't fit this thinking	Educate/replace staff
	longer traject with partners (compared to just selling)	Understand that it's a different world, don't push it
	Intensive trying get contract with bank, won't be perfect fit	Understand that it's a different world, don't push it
	Getting dedicated commitment from partners in supply chain and maintenance	Believe in your service, stand vast
Customer segment	Some segments are just not a fit	Just take small steps, if not perfect search further
customer relationships	People don't know PaaS	Dedicated M-use account manager
channels	No knowledge of service being provided	just respond with M-use rather then normal elevator
	No knowledge of service being provided	Create attention, beurzen, lezingen, CIRCL abn amro
	No market demand yet/small income of product	One big developer --> big order in one time
cost structure	Risk of bad contract	contract making, using, changing, validating
	Not enough income	One big developer --> big order in one time
revenue model	calculate end value, how to enlarge	?, giving the product a second life

Table 21. Overview of Mitsubishi's barriers and enablers according to the BMC. (own illustration)

Category	Barriers Theory	Barriers Mitsubishi
Financial	Low virgin material prices	Way of pre-financing
	lacking standardization	VAT extension on product
	High upfront investment costs	limited own resources
	Limited funding for circular business models	Intensive trying get contract with a bank, will not be a perfect fit
	Lack of data	calculate end value, how to enlarge
	Cash-flow problems	
	Difficulty defining which party pre-finances	
	High investment risk due to the long lease period	
	Service is more expensive in the long term than buying	

Table 22. Comparison of Financial barriers theory with Mitsubishi. (own illustration)

Category	Barriers Theory	Barriers Mitsubishi
Legal	Limited circular procurement	Retaining ownership
	Obstructing laws and regulations	New contract needed
	Lacking global consensus	Risk of an early contract ending
	Taxing system	No known contracts in the market
	Bouwbesluit	Too much due diligence on contract
		Risk of a bad contract

Table 23. Comparison of Legal barriers theory with Mitsubishi. (own illustration)

Category	Barrier in theory	Barriers Mitsubishi
Organisational	Hesitant company culture	Conservative environment
	Limited willingness to collaborate in the value chain	Existing company changing into new way
	Lacking consumer awareness and interest	Little PaaS thinking
	Operating in a linear system	Not having expertise inhouse
	Conservative industry	Not in DNA
	lack of support from senior management	Staff doesn't fit this thinking
	Lacking expertise	longer traject with partners (compared to just selling)
	Lack of strategic planning	Getting dedicated commitment from partners in supply chain and maintenance
	Lack of an ideal management information system	People don't know PaaS

Table 24. Comparison of Organisational barriers theory with Mitsubishi. (own illustration)

Category	Enablers in theory	Enablers Mitsubishi
Financial	For longterm projects create a project finance structure	Validate financial model, contract with financier
	Use future cashflow prediction to gain a loan	Fiscal research and calculate
	use your product as colleteral as basis for a loan if product is easily (re)moved	Contract with financier
	For existing companies, use your past relationship to create trust	giving the product a second life, create an end value
	Use public finance to close gaps in your balance sheets	
	Use risk sharing mechanisms to brigde gap between perceived and actual credit risk	
	Use up- and downstream partners to gain collaborative chain financing	

Table 25. Comparison of Financial enablers of theory with Mitsubishi. (own illustration)

Category	Enablers in theory	Enablers Mitsubishi
Organisational	Make use of the organisational change framework	Talk and offer circular PaaS option
	Develop a compeling narrative to convince employees	A lot of marketing
	Connect circular approach to existing practises that contributes to new circular model	Educate/replace staff
	Integrate circular ambitions in the company strategy	Create contract with external partner
	Reinforce the message by senior managers or influencers and leaders within the company	Understand that it's a different world, don't push it
	Use tangible examples for inside and outside the organisation	Believe in your service, stand vast
	Keep communicating simple and use common terminology within a variety of channels	Dedicated M-use account manager
	Give employees function-specific training and training on change management and systems thinking.	One big developer --> big order in one time
	Focus on building willingness to take an active role in the transformation of the company	
	Embed your circular methodology (deliverables, monitoring target) into day-to-day working	
	Design using a systems perspective to capture more value in products lifecycles	
	Control material flows by interface with up-/downstream partners	
	Have awareness campaigns	

Table 26. Comparison of Organisational enablers of theory with Mitsubishi. (own illustration)

Category	Enablers in theory	Enablers in Mitsubishi
Legal	Use a DBFM contract with pay back scheme	Research with external laywer (notaris?)
	Use a DBFM contract with transfer of ownership at end of contract	Create new contract with KPI
	Create a Circular Service Contract with ongoing service and no end date	Risk inventory
	To mitigate risks opting out clausula's should be incorporated	Invest, find new expertise people, talk with clients about contract forming
		Optimise by doing, true value analyse
		contract making, using, changing, validating

Table 27. Comparison of Legal enablers of theory with Mitsubishi. (own illustration)

APPENDIX D CASE ANALYSIS SIGNIFY

	Signify light-as-a-service	
	Barriers	Enablers
Value proposition	Other ways of financing for each client needed	Have multiple offerings of the service delivered (service, circular or amount saved)
	New contract form is needed	Determine financial value of product (and show as reduction on financing to customer)
	New unfimiliar stakeholder involved	Each stakeholder needs to gain something
	Favor of multiple stakeholders is needed	
	New way in market	
Key activities	Multiple departments and expertises are needed	Be the director of the logistics of the departments
	More expertise is needed than the company has	Do not try to have all the expertise in-house
	Multiple departments need to be managed and work together	Find key partners to do key activities
Key resources	Multiple expertise is needed on financial, marketing, logistics, legal and organisational	
	End of life calculation is important	
	The product needs to be able to evolve over time (specially layers with 10+ years lifespan)	
Key partners	Own resources are limited, financing is needed	Use financial experts in-house to create a relationship with a financier
	Providing services is not companies key activity	Use the banks skills of risk analysis on clients
	Getting in touch with financier is difficult	Search for partners to support key activities
	Getting in touch with key partners is difficult	
Customer segment	PaaS awareness is limited	Create multiple value propostions per segment
	Every segment has it own demands/needs	Create awereness with marketing on different levels
Customer relationships	PaaS awareness is limited	Create awereness with marketing on different levels
channels	Different go to markets, with different strategies needed	Use old clients to promote new service
		Focus on 1 or 2 go to markets
cost structure	Financing though external companies is costly not profitable	See the external financing not as income but as an extra service provided
	Competition for the product is big (for the service not yet)	To be beat the competition have fair prices on the product, and create extra value in the service
revenue model	Paying for the service is a deal breaker	Offer multiple options of financing and service providing

Table 28. Overview of Signify's barriers and enablers according to the BMC. (own illustration)

Category	Barrier Theory	Barrier Signify
Financial	Low virgin material prices	Other ways of financing for each client needed
	lacking standardization	End of life calculation is important
	High upfront investment costs	Own resources are limited, financing is needed
	Limited funding for circular business models	Getting in touch with financier is difficult
	Lack of data	Financing though external companies is costly not profitable
	Cash-flow problems	Paying for the service is a deal breaker
	Difficulty defning which party pre-finances	Create multiple value propostions per segment
	High investment risk due to long lease period	
	Service is more expensive on long term then buying	

Table 29. Comparison of Financial barriers of theory with Signify. (own illustration)

Category	Barrier Theory	Barrier Signify
Legal	Limited circular procurement	New contract form is needed
	Obstructing laws and regulations	
	Lacking global consensus	
	Taxing system	
	Bouwbesluit	

Table 30. Comparison of Legal barriers of theory with Signify. (own illustration)

Category	Barrier in theory	Barriers Signify
Organisational	Hesitant company culture	New unfimiliar stakeholder involved
	Limited willingness to collaborate in the value chain	Favor of multiple stakeholders is needed
	Lacking consumer awareness and interest	New way in market
	Operating in a linear system	Multiple departments and expertises are needed
	Conservative industry	More expertise is needed than the company has
	lack of support from senior management	Multiple departments need to be managed and work together
	Lacking expertise	Multiple expertise is needed on financial, marketing, logistics, legal and organisational
	Lack of strategic planning	Providing services is not companies key activity
	Lack of an ideal management information system	Getting in touch with key partners is difficult
		PaaS awareness is limited
		Every segment has it own demands/needs
		Different go to markets, with different strategies needed

Table 31. Comparison of Organisational barriers of theory with Signify. (own illustration)

Category	Enablers in theory	Enablers in Signify
Financial	For longterm projects create a project finance structure	Determine financial value of product (and show as reduction on financing to customer)
	Use future cashflow prediction to gain a loan	Use financial experts in-house to create a relationship with a financier
	use your product as colleteral as basis for a loan if product is easily (re)moved	Use the banks skills of risk analysis on clients
	For existing companies, use your past relationship to create trust	See the external financing not as income but as an extra service provided
	Use public finance to close gaps in your balance sheets	Offer multiple options of financing and service providing
	Use risk sharing mechanisms to brigde gap between perceived and actual credit risk	
	Use up- and downstream partners to gain collaborative chain financing	

Table 32. Comparison of Financial enablers of theory with Signify. (own illustration)

Category	Enablers in theory	Enablers in Signify
Legal	Use a DBFM contract with pay back scheme	Use KPI's to create contract
	Use a DBFM contract with transfer of ownership at end of contract	
	Create a Circular Service Contract with ongoing service and no end date	
	To mitigate risks opting out clausula's should be incorporated	

Table 33. Comparison of Legal enablers of theory with Signify. (own illustration)

Category	Enablers in theory	Enablers in Signify
Organisational	Make use of the organisational change framework	Have multiple offerings of the service delivered (service, circular or amount saved)
	Develop a compeling narrative to convince employees	Be the director of the logistics of the departments
	Connect circular approach to existing practises that contributes to new circular model	Do not try to have all the expertise in-house
	Integrate circular ambitions in the company strategy	Find key partners to do key activities
	Reinforce the message by senior managers or influencers and leaders within the company	Search for partners to support key activities
	Use tangible examples for inside and outside the organisation	Create awareness with marketing on different levels

	Keep communicating simple and use common terminology within a variety of channels	Use old clients to promote new service
	Give employees function-specific trainings and training on change management and systems thinking.	Focus on 1 or 2 go to markets
	Focus on building willengness to take an active role in the transformation of the company	To beat the competition have fair prices on the product, and create extra value in the service
	Embed your circular mehodology (deliverables, monitoring target) into day-to-day working	
	Design using a systems perspective to capture more value in products lifecycles	
	Control material flows by interface with up-/downstream partners	
	Have awareness campaigns	

Table 34. Comparison of Organisational enablers of theory with Signify. (own illustration)

APPENDIX E CASE ANALYSIS CHAINABLE

Chainable Kitchen-as-a-service		
	Barriers	**Enablers**
Value proposition	Different demands from the market	Start with interviews to find demands/problems in the market --> adjust value proposition to it
	Legal ownership is hard to define	buy-back proposition to keep track of circularity of product parts
	Bouwbesluit sees product as part of building	buy-back agreement for both parties (amount can be decided already for extra encouragement)
		Incorporate all Legal barriers in contract
		Create a ground lease construction for the product with the notary
		Create a suspension point for the product, which the client rents out to the company
		Test all legal options to see the barriers and enablers per option (multiple pilots)
Key activities	connection of the product with sewerage, electricity etcetera are not within expertise or key activities	Think ahead of activities which will grow with company sales, make them flexible to grow along
	As a start-up, you need to grow with the company and sales	
Key resources	pre-finance is difficult, especially the first initial investment of start-up	find a private financier for first starting capital
	Due to a long payback period and cashflow based income, finding financier is difficult	Find alternative income as a guarantee for payback loan. (per 2 full As-a-service, sell one regular product (with service))
Key partners	Key partners must take back parts, for the circularity of the product	Find a partner to help support growth
	Other parts by key partners are not designed with circular or sustainable principles	First sign an intention agreement with key partners, after that sign a collaboration agreement.
		Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)
		Support key partners with their obstacles
Customer segment	Consumer have too many demands	Corporations have enough money to pre-finance the product themselves
	Which market position are you going to take	
customer relationships		Having experts from traditional product-market can be a selling point to clients
		A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation
channels	the traditional market is filled by long-existing companies with existing client relations	know that you want to change the market, not overtake the market (or beat components)

	current channels within the traditional market are dominant and hard to overtake	The cold acquisition should be done through a research perspective rather than a commercial perspective (talk with the client about the circular product and ask how it can fit their needs)
cost structure	Trying to explain the added value of PaaS is difficult	Explain the benefits of usership --> ergonomics value or value of achieving circular goals
	PaaS is more expensive than just the product	Explain according to the cost of ownership (fewer repairs for example)
revenue model	Information details of parts are sensitive and not easily shared by partners	Have low margins and a more extended payback period to conquer the market
	Costs of service are hard to determine	Go along with the CE movement for the company to grow
	Good PaaS concept needs to grow exponentially, otherwise will be copied by others	

Table 35. Overview of Chainable's barriers and enablers according to the BMC. (own illustration)

Category	Barriers Theory	Barriers Chainable
Financial	Low virgin material prices	pre-finance is difficult, especially the first initial investment of start-up
	lacking standardization	Due to a long payback period and cashflow based income, finding financier is difficult
	High upfront investment costs	PaaS is more expensive than just the product
	Limited funding for circular business models	Costs of service are hard to determine
	Lack of data	
	Cash-flow problems	
	Difficulty defining which party pre-finances	
	High investment risk due to the long lease period	
	Service is more expensive in the long term than buying	

Table 36. Comparison of Financial barriers theory with Chainable. (own illustration)

Category	Barriers Theory	Barriers Chainable
Legal	Limited circular procurement	Legal ownership is hard to define
	Obstructing laws and regulations	Bouwbesluit sees product as part of building
	Lacking global consensus	
	Taxing system	
	Bouwbesluit	

Table 37. Comparison of Legal barriers theory with Chainable. (own illustration)

Category	Barrier in theory	Barriers Chainable
Organisational	Hesitant company culture	Different demands from the market
	Limited willingness to collaborate in the value chain	connection of the product with sewerage, electricity etcetera are not within expertise or key activities
	Lacking consumer awareness and interest	As a start-up, you need to grow with the company and sales
	Operating in a linear system	Key partners must take back parts, for the circularity of the product
	Conservative industry	Consumer have too many demands
	lack of support from senior management	Which market position are you going to take
	Lacking expertise	the traditional market is filled by long-existing companies with existing client relations
	Lack of strategic planning	current channels within the traditional market are dominant and hard to overtake
	Lack of an ideal management information system	Trying to explain the added value of PaaS is difficult
		Information details of parts are sensitive and not easily shared by partners
		Good PaaS concept needs to grow exponentially, otherwise will be copied by others

Table 38. Comparison of Organisational barriers theory with Chainable. (own illustration)

Category	Enablers in theory	Enablers Chainable
Financial	For longterm projects create a project finance structure	find a private financier for first starting capital
	Use future cashflow prediction to gain a loan	Find alternative income as a guarantee for payback loan. (per 2 full As-a-service, sell one regular product (with service))
	use your product as colleteral as basis for a loan if product is easily (re)moved	Corporations have enough money to pre-finance the product themselves
	For existing companies, use your past relationship to create trust	
	Use public finance to close gaps in your balance sheets	
	Use risk sharing mechanisms to brigde gap between perceived and actual credit risk	
	Use up- and downstream partners to gain collaborative chain financing	

Table 39. Comparison of Financial enablers of theory with Chainable. (own illustration)

Category	Enablers in theory	Enablers Chainable
Organisational	Make use of the organisational change framework	Start with interviews to find demands/problems in the market --> adjust value proposition to it
	Develop a compeling narrative to convince employees	buy-back proposition to keep track of circularity of product parts

	Connect circular approach to existing practises that contributes to new circular model	buy-back agreement for both parties (amount can be decided already for extra encouragement)
	Integrate circular ambitions in the company strategy	Think ahead of activities which will grow with company sales, make them flexible to grow along
	Reinforce the message by senior managers or influencers and leaders within the company	Find a partner to help support growth
	Use tangible examples for inside and outside the organisation	First sign an intention agreement with key partners, after that sign a collaboration agreement.
	Keep communicating simple and use common terminology within a variety of channels	Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)
	Give employees function-specific training and training on change management and systems thinking.	Having experts from traditional product-market can be a selling point to clients
	Focus on building willingness to take an active role in the transformation of the company	A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation
	Embed your circular methodology (deliverables, monitoring target) into day-to-day working	know that you want to change the market, not overtake the market (or beat components)
	Design using a systems perspective to capture more value in products lifecycles	Explain according to the cost of ownership (fewer repairs for example)
	Control material flows by interface with up-/downstream partners	Explain the cost of usership --> ergonomics value or value of achieving circular goals
	Have awareness campaigns	Have low margins and a more extended payback period to conquer the market
		Go along with the CE movement for the company to grow

Table 40. Comparison of Organisational enablers of theory with Mitsubishi. (own illustration)

Category	Solutions in theory	Chainable
Legal	Use a DBFM contract with pay back scheme	Create a ground lease construction for the product with the notary
	Use a DBFM contract with transfer of ownership at end of contract	Incorporate all Legal barriers in contract
	Create a Circular Service Contract with ongoing service and no end date	Create a suspension point for the product, which the client rents out to the company
	To mitigate risks opting out clausula's should be incorporated	Test all legal options to see the barriers and enablers per option (multiple pilots)

Table 41. Comparison of Legal enablers of theory with Chainable. (own illustration)

APPENDIX F SYNTHESISED BARRIERS

	Organisational barriers	Times mentioned					
OB1	Hesitant company culture						
OB2	Limited willingness to collaborate in the value chain						
OB3	Lacking consumer awareness and interest						
OB4	Operating in a linear system						
OB5	Conservative industry						
OB6	lack of support from senior management						
OB7	Lacking expertise						
OB8	Lack of strategic planning						
OB9	Lack of an ideal management information system						
OB10	Existing company changing into a new way						
OB11	longer traject with partners (compared to just selling)						
OB12	New unfamiliar stakeholder involved						
OB13	Multiple departments need to be managed and work together						
OB14	Providing certain services is not companies key activity						
OB15	Getting in touch with key partners is difficult						
OB16	Every segment has it own demands/needs						
OB17	Different go to markets, with different strategies needed						
OB18	As a start-up, you need to grow with the company and sales						
OB19	the traditional market is filled by long-existing companies with existing client relations						
OB20	Good PaaS concept needs to grow exponentially, otherwise will be copied by others						

Table 42. Overview of duplicates of Organisational barriers. (own illustration)

	Financial barriers	Times mentioned					
BF1	Low virgin material prices						
BF2	lacking standardization						
BF3	High upfront investment costs						
BF4	Limited funding for circular business models						
BF5	Lack of data						
BF6	Cash-flow problems						
BF7	Difficulty defining which party pre-finances						
BF8	High investment risk due to long lease period						
BF9	Service is more expensive on long term then buying						
BF10	VAT extension on product						
BF11	limited own resources						
BF12	Intensive trying get contract with a bank, won't be a perfect fit						
BF13	calculate end value and how to enlarge it						
BF14	Costs of service are hard to determine						
BF15	Getting in touch with financier is difficult						
BF16	Financing through external companies is costly, not profitable						
BF17	Each segment has different needs						

Table 43. Overview of duplicates of Financial barriers. (own illustration)

	Legal barriers	Times mentioned					
BL1	Limited circular procurement						
BL2	Obstructing laws and regulations						
BL3	Lacking global consensus						
BL4	Taxing system						
BL5	Bouwbesluit						
BL6	New contract form is needed						
BL7	Retaining ownership						
BL8	Risk of an early contract ending						
BL9	Too much due diligence on contract						
BL10	Risk of a bad contract						

Table 44. Overview of duplicates of Legal barriers. (own illustration)

	Other barriers	
Bo1	How to implement longer lifespan	
Bo2	Some segments are just not a fit	
Bo3	No knowledge of service being provided	
Bo4	No market demand yet	
Bo5	The product needs to be able to evolve (especially layers with 10+ years lifespan)	
Bo6	Competition for the product itself is significant (for the service not yet)	
Bo7	Other parts by key partners are not designed with circular or sustainable principles	

Table 45. Overview of duplicates of the Other barriers. (own illustration)

APPENDIX G SYNTHESISDED ENABLERS

	Organisational enablers
OE1	Make use of the organisational change framework
OE2	Develop a compelling narrative to convince employees
OE3	Connect circular approach to existing practises that contributes to new circular model
OE4	Integrate circular ambitions in the company strategy
OE5	Reinforce the message by senior managers or influencers and leaders within the company
OE6	Use tangible examples for inside and outside the organisation
OE7	Keep communicating simple and use common terminology within a variety of channels
OE8	Give employees function-specific trainings and training on change management and systems thinking.
OE9	Focus on building willingness to take an active role in the transformation of the company
OE10	Embed your circular methodology (deliverables, monitoring target) into day-to-day working
OE11	Design using a systems perspective to capture more value in products lifecycles
OE12	Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)
OE13	Have awareness campaigns
OE14	Have multiple offerings of the service delivered (service, circular or amount saved)
OE15	Be the director of the logistics of the departments
OE16	Do not try to have all the expertise in-house
OE17	Find key partners to do key activities
OE18	Use old clients to promote new service
OE19	Focus on 1 or 2 go-to markets
OE20	To beat the competition have fair prices on the product and create extra value in the service
OE21	Understand that it's a different world, don't push it
OE22	Start with interviews to find demands/problems in the market --> adjust value proposition to it
OE23	buy-back proposition to keep track of circularity of product parts
OE24	buy-back agreement for both parties (amount can be decided already for extra encouragement)
OE25	Think ahead of activities which will grow with company sales, make them flexible to grow along
OE26	Find a partner to help support growth
OE27	First sign an intention agreement with key partners, after that sign a collaboration agreement.
OE28	Having experts from traditional product-market can be a selling point to clients
OE29	A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation
OE30	Go along with the CE movement for the company to grow
OE31	know that you want to change the market, not overtake the market (or beat components)
OE32	Explain according to the cost of ownership (fewer repairs for example)
OE33	Explain the cost of usership --> ergonomics value or value of achieving circular goals

Table 46. Overview of duplicates of Organisational enablers. (own illustration)

Finance enablers					
EF1	For longterm projects create a project finance structure				
EF2	Use future cashflow prediction to gain a loan				
EF3	use your product as colleteral as basis for a loan if product is easily (re)moved				
EF4	For existing companies, use your past relationship to create trust				
EF5	Use public finance to close gaps in your balance sheets				
EF6	Use risk sharing mechanisms to brigde gap between perceived and actual credit risk				
EF7	Use up- and downstream partners to gain collaborative chain financing				
EF8	Validate financial model, contract with financier				
EF9	Fiscal research and calculate				
EF10	Contract with financier				
EF11	Understand that it's a different world, don't push it				
EF12	Use financial experts in-house to create a relationship with a financier				
EF13	Use the bank's skills of risk analysis on clients				
EF14	See the external financing not as income but as an extra service provided				
EF15	Offer multiple options of financing and service providing				
EF16	find a private financier for first starting capital				
EF17	Find alternative income as a guarantee for payback loan. (per 2 full As-a-service, sell one regular product (with service))				
EF18	Corporations have enough money to pre-finance the product themselves				

Table 47. Overview of duplicates of Finance enablers. (own illustration)

Legal enablers					
EL1	Use a DBFM contract with pay back scheme				
EL2	Use a DBFM contract with transfer of ownership at end of contract				
EL3	Create a Circular Service Contract with ongoing service and no end date				
EL4	To mitigate risks opting out clausula's should be incorporated				
EL5	Use KPI's to create a contract				
EL6	Research with an external notary				
EL7	Risk inventory				
EL8	contract making, using, changing, validating				
EL9	Create a ground lease construction for the product with the notary				
EL10	Incorporate all Legal barriers in contract				
EL11	Create a suspension point for the product, which the client rents out to the company				
EL12	Test all legal options to see the barriers and enablers per option (multiple pilots)				

Table 48. Overview of duplicates of Legal enablers. (own illustration)

Other enablers		
Eo1	Add intelligence (sensors), new maintenance approach	
Eo2	Just take small steps, if not perfect search further	
Eo3	just respond with PaaS instead of traditional product	
Eo4	Create attention by going to exhibitions, lectures, or use pilot projects as an example.	
Eo5	One big developer, to gain a big order in one time	
Eo6	Each stakeholder needs to gain something	
Eo7	The cold acquisition should be done through a research perspective rather than a commercial perspective (talk with the client about the circular product and ask how it can fit their needs)	
Eo8	Support key partners with their obstacles	

Table 49. Overview of duplicates of Other enablers. (own illustration)

APPENDIX H BARRIER AND ENABLER OVERVIEW

Code	Barriers	Code	Enablers
OB1	Hesitant company culture	OE1	Make use of the organisational change framework
OB2	Limited willingness to collaborate in the value chain	OE2	Develop a compeling narrative to convince employees
OB3	Lacking consumer awareness and interest	OE3	Connect circular approach to existing practises that contributes to new circular model
OB4	Operating in a linear system	OE4	Integrate circular ambitions in the company strategy
OB5	Conservative industry	OE5	Reinforce the message by senior managers or influencers and leaders within the company
OB6	lack of support from senior management	OE6	Use tangible examples for inside and outside the organisation
OB7	Lacking expertise	OE7	Keep communicating simple and use common terminology within a variety of channels
OB8	Lack of strategic planning	OE8	Give employees function-specific trainings and training on change management and systems thinking.
OB9	Lack of an ideal management information system	OE9	Focus on building willengness to take an active role in the transformation of the company
OB10	Existing company changing into a new way	OE10	Embed your circular methodology (deliverables, monitoring target) into day-to-day working
OB11	longer traject with partners (compared to just selling)	OE11	Design using a systems perspective to capture more value in products lifecycles
OB12	New unfamiliar stakeholder involved	OE12	Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)
OB13	Multiple departments need to be managed and work together	OE13	Have awareness campaigns
OB14	Providing certain services is not companies key activity	OE14	Have multiple offerings of the service delivered (service, circular or amount saved)
OB15	Getting in touch with key partners is difficult	OE15	Be the director of the logistics of the departments
OB16	Every segment has it own demands/needs	OE16	Do not try to have all the expertise in-house
OB17	Different go to markets, with different strategies needed	OE17	Find key partners to do key activities
OB18	As a start-up, you need to grow with the company and sales	OE18	Use old clients to promote new service
OB19	the traditional market is filled by long-existing companies with existing client relations	OE19	Focus on 1 or 2 go-to markets
OB20	Good PaaS concept needs to grow exponentially, otherwise will be copied by others	OE20	To beat the competition have fair prices on the product and create extra value in the service
		OE21	Understand that it's a different world, don't push it
		OE22	Start with interviews to find demands/problems in the market --> adjust value proposition to it

		OE23	buy-back proposition to keep track of circularity of product parts
		OE24	buy-back agreement for both parties (amount can be decided already for extra encouragement)
		OE25	Think ahead of activities which will grow with company sales, make them flexible to grow along
		OE26	Find a partner to help support growth
		OE27	First sign an intention agreement with key partners, after that sign a collaboration agreement.
		OE28	Having experts from traditional product-market can be a selling point to clients
		OE29	A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation
		OE30	Go along with the CE movement for the company to grow
		OE31	know that you want to change the market, not overtake the market (or beat components)
		OE32	Explain according to the cost of ownership (fewer repairs for example)
		OE33	Explain the cost of usership --> ergonomics value or value of achieving circular goals

Table 50. Synthesised overview of the category Organisation. (own illustration)

code	Barriers	code	Enablers
BF1	Low virgin material prices	EF1	For longterm projects create a project finance structure
BF2	lacking standardization	EF2	Use future cashflow prediction to gain a loan
BF3	High upfront investment costs	EF3	use your product as colleteral as basis for a loan if product is easily (re)moved
BF4	Limited funding for circular business models	EF4	For existing companies, use your past relationship to create trust
BF5	Lack of data	EF5	Use public finance to close gaps in your balance sheets
BF6	Cash-flow problems	EF6	Use risk sharing mechanisms to brigde gap between perceived and actual credit risk
BF7	Difficulty defining which party pre-finances	EF7	Use up- and downstream partners to gain collaborative chain financing
BF8	High investment risk due to long lease period	EF8	Validate financial model, contract with financier
BF9	Service is more expensive on long term then buying	EF9	Fiscal research and calculate
BF10	VAT extension on product	EF10	Contract with financier
BF11	limited own resources	EF11	Understand that it's a different world, don't push it
BF12	Intensive trying get contract with a bank, won't be a perfect fit	EF12	Use financial experts in-house to create a relationship with a financier
BF13	calculate end value and how to enlarge it	EF13	Use the bank's skills of risk analysis on clients
BF14	Costs of service are hard to determine	EF14	See the external financing not as income but as an extra service provided
BF15	Getting in touch with financier is difficult	EF15	Offer multiple options of financing and service providing
BF16	Financing through external companies is costly, not profitable	EF16	find a private financier for first starting capital
BF17	Each segment has different needs	EF17	Find alternative income as a guarantee for payback loan. (per 2 full As-a-service, sell one regular product (with service))
		EF18	Corporations have enough money to pre-finance the product themselves

Table 51. Synthesised overview of category Finance

Code	Barriers	Code	Enablers
BL1	Limited circular procurement	**EL1**	Use a DBFM contract with pay back scheme
BL2	Obstructing laws and regulations	**EL2**	Use a DBFM contract with transfer of ownership at end of contract
BL3	Lacking global consensus	**EL3**	Create a Circular Service Contract with ongoing service and no end date
BL4	Taxing system	**EL4**	To mitigate risks opting out clausula's should be incorporated
BL5	Bouwbesluit	**EL5**	Use KPI's to create a contract
BL6	New contract form is needed	**EL6**	Research with an external notary
BL7	Retaining ownership	**EL7**	Risk inventory
BL8	Risk of an early contract ending	**EL8**	contract making, using, changing, validating
BL9	Too much due diligence on contract	**EL9**	Create a ground lease construction for the product with the notary
BL10	Risk of a bad contract	**EL10**	Incorporate all Legal barriers in contract
		EL11	Create a suspension point for the product, which the client rents out to the company
		EL12	Test all legal options to see the barriers and enablers per option (multiple pilots)

Table 52. Synthesised overview of the category Legal. (own illustration)

Code	Barriers	Code	Enablers
Bo1	How to implement longer lifespan	Eo1	Add intelligence (sensors), new maintenance approach
Bo2	Some segments are just not a fit	Eo2	Just take small steps, if not perfect search further
Bo3	No knowledge of service being provided	Eo3	just respond with PaaS instead of traditional product
Bo4	No market demand yet	Eo4	Create attention by going to exhibitions, lectures, or use pilot projects as an example.
Bo5	The product needs to be able to evolve (especially layers with 10+ years lifespan)	Eo5	One big developer, to gain a big order in one time
Bo6	Competition for the product itself is significant (for the service not yet)	Eo6	Each stakeholder needs to gain something
Bo7	Other parts by key partners are not designed with circular or sustainable principles	Eo7	The cold acquisition should be done through a research perspective rather than a commercial perspective (talk with the client about the circular product and ask how it can fit their needs)
		Eo8	Support key partners with their obstacles

Table 53. Synthesised overview of the category Other. (own illustration)

APPENDIX I FINAL RESULTS

Rank	Mentioned	Code	Organisation barrier
1	3	**OB16**	Every segment has it own demands/needs (need to be inventarised)
1	2	**OB17**	Different go to markets, with different strategies needed (which position in the market to take?)
3	6	**OB7**	**Lacking expertise**
4	2	**OB5**	**Conservative industry**
5	4	**OB3**	**Lacking consumer awareness and interest**
5	2	**OB19**	the traditional market is filled by long-existing companies with existing client relations
7	2	**OB10**	Existing company changing into new way
8	2	**OB12**	New unfamiliar stakeholder involved
8	2	**OB14**	Providing certain services is not companies key activity
10	2	**OB4**	**Operating in a linear system**
11	5	**OB2**	**Limited willingness to collaborate in the value chain**
12	2	**OB1**	**Hesitant company culture**

Table 54. Final results organisational barriers. (own illustration)

Rank	relations	Code	Organisation enabler
1	**6**	**OE19**	Focus on 1 or 2 go-to markets
2	**4**	**OE12**	Create financial incentives to create parts that suit your product. (pay cost-price with a yearly bonus if the product still functions well)
3	**4**	**OE3**	**Connect circular approach to existing practises that contributes to new circular model**
4	**4**	**OE15**	Be the director of the logistics of the departments
5	**4**	**OE25**	Think ahead of activities which will grow with company sales, make them flexible to grow along
6	**5**	**OE26**	Find a partner to help support growth
7	**4**	**OE10**	**Embed your circular methodology (deliverables, monitoring target) into day-to-day working**
8	**5**	**OE29**	A service is an agreement for an extended period, tell clients you will be present in the company for a long time to create relationships based on long time cooperation
9	**4**	**OE27**	First sign an intention agreement with key partners, after that sign a collaboration agreement.
9	**3**	**OE16**	Do not try to have all the expertise in-house
11	**5**	**OE30**	**Go along with the CE movement for the company to grow**
11	**4**	**OE8**	**Give employees function-specific trainings and training on change management and systems thinking.**

Table 55. Final results organisational enablers. (own illustration)

Rank	Mentioned	Code	Finance barrier
1	**2**	**BF6**	**Cash-flow problems**
2	**2**	**BF13**	calculate end value and how to enlarge it
2	**2**	**BF8**	**High investment risk due to long lease period**
4	**2**	**BF11**	**limited own resources**
5	**3**	**BF9**	**Service is more expensive on long term then buying**
6	**2**	**BF2**	**lacking standardization**
7	**3**	**BF7**	**Difficulty defining which party pre-finances**

Table 56. Final results Financial barriers. (own illustration)

Rank	Relations	Code	Finance enabler
1	**5**	**EF10**	Contract with financier
2	**5**	**EF18**	Corporations have enough money to pre-finance the product themselves
3	**4**	**EF16**	find a private financier for first starting capital
3	**5**	**EF4**	**For existing companies, use your past relationship to create trust**
3	**5**	**EF5**	**Use public finance to close gaps in your balance sheets**
6	**4**	**EF3**	**use your product as colleteral as basis for a loan if product is easily (re)moved**
6	**5**	**EF7**	**Use up- and downstream partners to gain collaborative chain financing**

Table 57. Final results Financial enablers. (own illustration)

Rank	Mentions	Code	Legal barrier
1	2	**BL7**	Retaining ownership
2	3	**BL6**	New contract form is needed
3	2	**BL5**	**Bouwbesluit**

Table 58. Final results legal barriers. (own illustration)

Rank	Relations	Code	Legal enabler
1	**3**	**EL10**	Incorporate all Legal barriers in contract
2	**3**	**EL6**	Research with an external notary
2	**3**	**EL11**	Create a suspension point for the product, which the client rents out to the company
4	**4**	**EL8**	contract making, using, changing, validating
4	**3**	**EL9**	Create a ground lease construction for the product with the notary

Table 59. Final results legal enablers. (own illustration)