At your service!
Circular business model prototypes for a service provider in the construction industry
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To all of those that pushed me towards this achievement,
  a big, ill-frequented, thank you.
Preface

This report forms the master’s thesis of Robert van den Brink for the curriculum of Management in the Built Environment at the faculty of Architecture, Urbanism, and Building Sciences at Delft University of Technology. As such it is the closing note of the study programmes that I followed with a lot of enthusiasm over the years.

The topic at hand in this report deals with the implementation of the circular economy in the construction industry. In recent years the circular economy has gained significant popularity, however practical implementation of the concept has not followed accordingly. Especially in the construction industry there is a need for a practical translation of the concept.

This research makes this translation through the mutual development of circular economy theory and business model prototypes for a circular construction industry. With the development of both the prototypes and theory, two important questions surrounding the circular economy are answered in this research. First, how should a service provider organize itself according to the circular economy, and second, how does the service provider relate to current stakeholders in the construction process?
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Management Summary

At your service!
Circular business model prototypes for
a service provider in the construction industry

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Abstract
In recent years the circular economy has gained significant popularity, however practical implementation of the concept has not followed accordingly. Especially in the construction industry there is a need for a practical translation of the concept. This research makes this translation through the mutual development of circular economy theory and business model prototypes for a circular construction industry. These prototypes are aimed at service providers in the construction industry as it follows from a literature study that these are essential in developing the circular economy in the construction industry. With the development of both the prototypes and theory two important questions surrounding the circular economy are answered in this research. First, how should a service provider organize itself according to the circular economy, and second, how does the service provider relate to current stakeholders in the construction process?

Keywords:
Circular economy, service provider, business model prototype, construction industry

1. Introduction
Since the beginning of the Industrial Revolution 200 years ago our economy has been characterized with consuming. Nowadays products are even designed in a way that they do not live up to our expectations after a few years. This is because in the current economy companies benefit from a short lasting product. Planing (2014) and Stahel (2012) describe this as a misaligned profit-share along the supply chain, causing imperfect product design. The circular economy concept imposes a shift from this linear consumption pattern to circular consumption. The circular economy concept stems from the believe that linear consumption will reach its limits in the foreseeable future, and builds upon different earlier concepts like for instance cradle-to-cradle theory (Ellen MacArthur Foundation, 2014; Van Dijk et al., 2014). Circular economy is differs from these concepts in that it proposes a concept from the thought of economics, whereby sustainability can be seen as the major catch alongside a change in systems, whereas the cradle-to-cradle philosophy and other schools of thought focus more on the ‘loops’ and re-use themselves. The above notion comes best to the fore in what the circular economy tries to do when it comes to incentivizing different actors in the process. In the circular economy theory it is in the producer’s own interest to follow the cycles as he stands to gain most from it, this is because in circular economy theory the producer often does not sell his or her product but leases it to the customer (Bakker et al., 2014; Ellen MacArthur Foundation, 2014; Roos, 2014). In doing so, the circular economy will make it more attractive for manufacturers to make sustainable, durable products that are able to ‘ride the life cycles’. A more sustainable and durable world in a circular economy is therefore more of a consequence of the incentive shift as opposed
to the goal through the entire process as proposed by cradle-to-cradle thinking.

The circular economy theory as provided by the Ellen MacArthur Foundation should not be accepted without criticism; due to the current state of literature and theory it is for instance as of yet not possible to give one generally used definition of a circular economy (Mentink, 2014). According to Kok et al. (2013), Mentink (2014) and De Grauw (2015) there is no clear definition, since the transition to a circular economy will be a non-linear process, in which many aspects are uncertain. However, this seems to hollow the concept of circular economy towards a popular term or so-called ‘empty barrel’ Mentink (2014). Also beyond the definition there are some issues to be reckoned with in relation to the circular economic concept. The Ellen MacArthur Foundation (2014) for instance states that merely six principles are needed to implement the circular economy, further research by Mentink (2014) shows that these principles are not sufficient at all for implementation and that these are not the most important principles in the transition towards a circular economy either. As it is impossible to continue this research without a general definition of the circular economy, this research will provide one with several side notions in order to make this definition operational. Due to the vague boundaries the definition of the circular economic concept should be kept at a relatively high abstraction level. Therefore an adapted definition of Mentink (2014) provides the best definition of the circular economy concept:

“a circular economy is an economic system with cyclical material loops based on a financial incentive.”

Wherein ‘economic system’ refers to a combination of more than one interrelated parts or components that show how people deal with scarcity, ‘cyclical material loops’ refers to a loop that makes it possible for materials to keep cycling in these loops, and where ‘a financial incentive’ refers to a prospect on financial merits. Considering the shortcomings that were established in current literature, the following requirements (or acknowledgements) ground the definition of a circular economy in order to make it more than an empty barrel.

1. A circular economy can never be fully circular (which is the reason in the definition itself, the term closed loops is replaced by cyclical loops). A circular economy should however aim to come as close to a 100% circular economy as possible.
2. Life extension is not considered another loop as the product stays the same, no further alterations are required for this action. This has therefore nothing to do with circular design.
3. Downgrading through/or recycling is not a problem when it prevents using new resources.
4. In industries where there are several steps that need to be taken from mining a resource towards making it a product it should be examined at industry level which party should retain ownership of the needed resources.

1.2 The construction industry

Although some products are already connected to the circular economy through for instance experiments of companies, there is little to no material to be found on the implementation of the circular economy in the construction industry (Bakker et al., 2014; Bom, 2012). This is despite of the fact that real estate is responsible for one third of global energy use, also 40-50% of raw materials that are used each year are devoted to the construction industry, and the sector accounts for 40% of solid waste streams (Antink et al., 2014). There is therefore a need to translate the circular economy to the construction industry.

Currently the construction industry can be characterized by its project-based nature, delivering unique products (i.e. buildings) (Vrijhoef, 2011). Where the building can be seen as a collection of different components that together form an entity that can be described as a building. A building is as such a collection of interrelated parts or components at different scale levels (Prins, 1992). Due to the uniqueness of its products, each and every project in the industry is also different from one-another, with a different composition of stakeholders and composition of products in each project (Eastman et al., 2008; Segerstedt & Olofsson, 2010; Wamelink, 2010). Therefore a production chain like ‘make-to-stock’, which is common in other manufacturing industries, does not exist in the construction industry.
(Segerstedt & Olofsson, 2010). Also there is not a lot of thought given to end-of-life situations, probably because of the long time span surrounding the buildings. Furthermore, the different components within the building have different lifetimes. Next to that, the industry is capital-intensive and relies a lot on manual labour in order to realize its products (Vrijhoef & Koskela, 2000).

In order to counteract the above described characteristics, attempts have been made at partnering within the construction industry. The main arguments for partnering and supply chain integration within the construction industry are that it would lead to; increased effectiveness and efficiency, commercial success, improvement of both joint and individual companies’ performance, and a better end-product (Vrijhoef, 2011). Within the construction industry, the amount of partnering involved in a certain project is mostly covered by the form of the contract that is used (Wamelink, 2010). In this way the contracts form a partnership between client and main contractor (who frequently represents the supply side during construction (Vrijhoef, 2011)), but leaves out any possible partnerships between the supplying parties themselves (Bygballe et al., 2010). This plays its part in the short-term focus of the supply-side parties in the construction industry (Bygballe et al., 2010). However the demand-side of the industry also plays a part in this short-term focus through the great influence the client has in a construction project. Despite this influence, the client is seen as the most important actor in construction supply chain integration (Vrijhoef and De Ridder, 2005). This however stems from the absence of a supply side focal firm on the supply side of the construction industry. Which explains why, as of yet, the industry only managed to come up with informal, pragmatic solutions when compared to other manufacturing industries (Vrijhoef, 2011), and why supply chain integration is difficult in the construction industry.

1.3 The construction industry and the circular economy
As of yet there is however no precedent of what the construction process is going to look like under the influence of the circular economy, therefore three different short exercises show the practical implications of implementation of the circular economy in the construction industry. From these exercises it can be concluded that; when circular economy theory is brought to the ‘standard’ construction process as it was described above, the division between ownership and supplying party changes and becomes blurry, it also affects the time scope of the involved parties. When it comes to business financing, it can be said that leasing the objects constructed instead of selling them in order to retain ownership does not make sense from a supplier’s perspective. Leasing impacts both the company’s liquidity and solvability in a negative way. It also causes a lot of deadweight capital in the form of solid assets on the company’s balance sheet. From the second year onwards, the company’s result would recover for the most part, however there would still remain a loss when compared to the selling strategy. Other strategies like a buy-buy-back model or reintroducing a product were also found to be unlikely profitable activities. When it comes to building components (i.e. the products) a shift in demands will be needed when circular economy theory is implemented. Furthermore, the amount of individual building components plays a role in the feasibility of the circular economy in the construction industry, where the more components inherent in a building the less likely it seems that circular construction is feasible.

When comparing the exercises with general obstacles that are encountered when moving towards a circular economy (provided by Kok et al. (2013)), it becomes clear that the problems surrounding the implementation of the circular economy in the construction industry reside along the categories ‘financial’ and ‘technological’. The biggest match is however made with the institutional obstacle; ‘governance issues concerning responsibilities, liabilities, and ownership’. In the context of the construction industry it would however be more fitting to talk about an organizational obstacle at the level of the individual actors amongst themselves.

1.4 Finding the incentive in the construction industry
In what way can the circular economy be implemented in the construction industry, bearing in mind the difficulties that were found earlier? First off, a circular construction industry would need to offer products that make it possible for the supplying parties to
offer a performance or service towards the customer (hence, the client will most likely not become the owner of the product, therefore the use of a product should yield a certain degree of utility with the user (i.e. a certain performance)). In this research the following definition of performances and services will be used (adapted from De Grauw, 2015):

‘A performance is an agreed upon action of performing that results in an output, utility, goal, function, or commitment whereby the product is not a goal in itself, but enabling the performance. Secondly, the service is mainly a non-physical action or operation whereby the performance is optimized over time.’

This will in turn lead to a new definition of a building:

‘A collection of products that together form an entity that can be described as a building. A building is as such a collection of interrelated products at different scale levels (adapted from Prins, 1992).’

Secondly, the organizational problem in the construction industry resides around a scale problem within the project organization. It has also become clear that this scale problem is not easily dealt with through delegating ownership to one of the parties that are currently present in the project organization scheme. In effect it has become clear through these exercises and literature that a circular economy needs system optimization, new production processes, new ownership relations, networks and chains (Van de Kaa, 2013), furthermore the step from a linear towards a circular economy will increase the complexity of said processes, relations, networks and chains (Geldermans & Rosen Jacobson, 2015), while at the same time the need to work together will increase (Bastein et al., 2013).

Therefore a new entity needs to be set up in order to be able to deal with the aforementioned problems. Implementing a new entity within the project organization (albeit only for research purposes), would create a clear focal firm for the supply side of the construction industry, eliminating existing barriers towards collaboration between the supplying parties in the industry. The new entity therefore provides an opportunity to study what the supply side needs to offer in a circular construction industry without being hindered by current conventions. The new entity will be called a ‘service provider’ from now on as it is positioned in between the supplying parties and the building and the other stakeholders present in the project organization (see figure S1). The general idea of a service provider is not new, in fact the Ellen MacArthur Foundation (2012) already implemented a service provider in their

![Figure S1: Depiction of the organization of a building project with problem statement depicted (own figure)](image)
depiction of the concept. However the service provider as it is proposed here differs from the one that is proposed by the Ellen MacArthur Foundation (2012) in that the operations and all of the surrounding relationships of the service provider are the subject of investigation. This while the service provider as proposed by the Ellen MacArthur Foundation has a fixed position in the concept with fixed, unclear operations and relations, thereby surpassing deeper research into its role without properly understanding it. With this position, the service provider role would form the basis for solving the problems that were stated in previous sections and incentivize the stakeholders in the right way. It would have to do so through effectively managing the two different transactions surrounding it:

- The transaction between the service provider and the user
- The transaction between the service provider and the supplying parties

2. Methodology

Following the analysis made in the introduction, the main research question posed in this research consists of two parts, which are:

‘How to organize a service provider at the building level in such a way that its role adheres to the definition and principles of the circular economy?’

and secondary:

‘How does this service provider relate to the current supply- and demand side stakeholders in the construction process?’

The research question is a translation of the research problem and will essentially have to deal with the organizational setup of the service provider and two different transactions; one between the user and the service provider, and one between the service provider and the supplying parties. This research will focus on these particular transactions as circular economy will have the biggest organizational impact on the supply side of the construction organization. How to deal with this organization and these transactions will become clear through several detailed research questions that will be elaborated upon below. Through the secondary question it will become clear to what degree current parties can relate themselves to the role of the service provider. And by that it will also be apparent to them how far they are currently off from being a circular actor, enhancing the practical relevance of this research.

The final result

The research should therefore yield a final result in the form of different business model prototypes. These provide insights and/or solutions as to how the service provider will deal with the ‘new’ context the circular economy provides for the supplying parties in the construction industry. It is chosen to create different variants of business model prototypes as the lessons learned do not point towards one single way in which the service provider can organize its business. Each variant will be presented through the sustainable business model framework as presented by Bocken & Short (2015). This business model framework offers guidelines as to how to generate new business models and shows the relationship between different actors and resources. By using this framework it will become clear in what way the role of the service provider will function in the construction industry.

Relevance of the research

Existing literature on the circular economy often gets stuck at an abstract level, making it hard to connect the circular economy to for instance people, companies, projects, processes, and business sectors (Antink, et al., 2014; De Grauw, 2015; Ellen MacArthur Foundation, 2014; Kok et al., 2013; Mentink, 2014; Van Dijk et al., 2014). In other words there is a literature gap on the practical implementation of the circular economy. When a look is given to the construction industry it becomes apparent that there is (through the aforementioned literature gap) also a literature gap in this particular industry. Although there has recently been an influx of research on the circular construction industry at the faculty of architecture and the built environment at Delft University of Technology in an attempt to close this gap, none of this research focuses on the circular service provider from a supply-side perspective. This research is therefore unique in that (1) it investigates the circular construction service provider from a supply-side perspective, and (2) does this from a carefully built-up
theoretical construct that critically reflects upon both existing circular economy theory and the current construction industry before coupling the construct back to practice. Therefore general aims of this research are to bridge the literature gaps by providing a practical model implementing the circular economy within the construction industry while on a higher abstraction level working out the circular economic concept as well. On a societal level the opportunities of the circular economy are estimated to create 54,000 jobs and €7.3bn in annual savings in the Netherlands alone (Bastein et al., 2013). On a practical level, the results of this research will be applicable to all supplying parties in a circular construction industry, and will be the first (as far as the knowledge of the author is concerned) business model prototypes for a service provider in a circular construction industry from a supply-side perspective.

**General research method**

What sets this research apart from most other researches is the fact that there is little or no earlier literature available that is useful for this particular research. There is, as of yet, therefore also no paradigm on which to build further research. These features indicate that pragmatic research methods are the best solution for this research. Therefore inspiration will be drafted from the case study approach as proposed by Eisenhardt (1989). However, this research will not copy the research process as laid out by Eisenhardt (1989) one-on-one, as some parts of this method are not seen as an option in this particular research. Therefore Eisenhardt’s (1989) method will be used in this research as a guideline as to how to deal with different data gathering methods and as an example on how to treat the gathered data. These data gathering methods will be used in the research design as it is presented in figure S2.

**3. Literature study**

It was established that in order for the circular construction industry to function properly, a service provider is needed. It was also found that such an actor is as of yet not present in the construction industry. Therefore this section takes a look at other industries to see what can be learned and which of those lessons can be transferred to the circular construction industry. Thereafter a look will be given at the way in which other sustainable concepts have been implemented by several case-companies, the lessons learnt here will also be transferred to the circular construction industry.
3.1 Service providers in other industries

Although in these other industries the present service providers do not make use of circular economic concepts, they do offer a perspective on the functioning of such a role, as the role of the service provider is more mature in those industries (Schmenner, 2009). Therefore the description of the role of the service provider as it is implemented in other industries forms the basis for a comparison between these other industries and the construction industry.

Before a deeper look is taken at what kind of activities a service provider performs in other industries. It is useful to take a look at what kind of party the service provider is in other industries. Baines and Lightfoot (2013), Biege et al. (2012), and Tukker (2004) make a distinction between pure service providers and manufacturing service providers. Whereby the first form focuses on delivering services without having any physical, underlying product (e.g. consultancy firms), and the latter form offers a combination of a manufacturer and the first form. This makes the last form a crossover between a pure manufacturer and a pure service provider, which offers services based on underlying products. The offering of services based on underlying products shows close relevance to the earlier established definition of a building and that of performances. It is for this reason (and for more reasons that will become apparent in the next few sections) that this crossover form is most relevant for the circular construction industry, and will be studied in further depth.

To do so, use is made of a research about ‘servitization’ made by Baines and Lightfoot (2013). Through this research they found that a service provider appears in an industry because of five different perspectives; an economic perspective, an environmental perspective, a market and social perspective, a technology innovation perspective, and a knowledge perspective. Note that many of these perspectives correlate to the concept of circular economy or to the definitions and requirements as they were introduced earlier on in this article. Further research shows that it is indeed possible to obtain financial gain from offering services, however for this gain to have any impact on the company that offers these services, the provision of services needs to be a substantial part of the company's operations (20-30% at least) and the services need to be related to the provider’s core business (Fang et al., 2008). This indicates that in order for service provision to become effective, considerable investments might be necessary, which might be one of the reasons manufacturers might be reluctant in adopting them (Tukker, 2004). In addition, when the offered services focus solely on the product (e.g. maintenance) the environmental improvement will be relatively modest (10-20% when compared to the non-service scenario). Higher environmental gains are however to be expected of services that are result and/or ability-driven (Tukker, 2004).

So besides different kinds of service providers, there are also different kinds of services (product-focused or result-/ability-focused services). According to Baines and Lightfoot (2013), there are three types of different services that a service provider can offer: base, intermediate, and advanced services. The first two types are product-focused, and advanced services are result- or ability focused services.
Advanced services show to have the highest affinity with circular economic theory as it is introduced in this article. These advanced services are delivered through a product-service system in which the focus for the manufacturer is on: (1) an ability to respond cost effectively, and (2) an ability to improve cost effectiveness (Biege et al., 2012; Tukker, 2004). In order to be able to deliver on these two main capabilities the manufacturer has to ‘stretch’ its organization as far as is needed, without impeding on the customer’s core business and with careful consideration of its suppliers. Thereby the stretch of the manufacturer’s services depends upon the core activities of the customer for the ‘forward’ stretch and upon the core activities of the manufacturer for the ‘backward’ stretch (Bastl et al., 2012). This shows that offering advanced services asks for careful coordination and communication with the customer in order not to engage in the customer’s core activities (Windahl & Lakemond, 2006). Also the relationship between the service provider and its suppliers might change (Bastl et al., 2012; Oliva & Kallenberg, 2003; Windahl & Lakemond, 2006), therefore also in this case careful coordination is needed between these two parties. This is the case as the organizational stretch might cause the service provider and a supplier to compete on the same product (Bastl et al., 2012).

The service providers that were found in other industries are all based in established fabrication industries, and they produce homogenous products. Furthermore, all five manufacturers have deliberately chosen to compete in the market with services instead of their products alone. In this way the manufacturers attempt to differentiate themselves from competitors.

3.2 The implementation of sustainable concepts in other industries
Research by Dangelico and Pujari (2010) shows that companies integrate sustainability into their business for three different reasons (which can all be relevant at the same time). The first reason is to comply with regulations, this as governmental regulations are steering more and more towards sustainability. The second reason is to improve the competitiveness of a company, particularly sustainable products are seen as a way of improving competitiveness through better reputation and image of a company. Thirdly, ecological responsibility is seen as a reason to opt for sustainable strategies.

Different case studies clarify that there are different reasons for companies to operate in a circular or cradle-to-cradle way. Even though the viewpoint of the studied companies on sustainability is different, some similarities emerge in their business operations as a consequence of this sustainability focus. Every case study company engages in tighter supply chain management and starts to offer services based upon their products. Furthermore two out of three case study companies also started product monitoring during the use phase of the products, in order to ensure optimal functioning of these products. In all of the industries of the case study companies the products on offer are, in general, quite homogenous. By offering services alongside the products as well as a focus on sustainability, the case study firms are looking to differentiate themselves from competitors.
3.3 Lessons to be learned for a circular construction industry

A general lesson to be learned about the circular economy through the comparison with other industries is that there are multiple ways to go about the circular economy. These ways are dependent upon what service a client wants to receive with a certain product, these could either be base, intermediate, or advanced services (although advanced services show the highest affinity with the circular economic concept). This observation has led to figure S3, which features an incorporation of the service levels as distinguished by Baines and Lightfoot (2013), and the circular economic concept (hereafter referred to as the circular service level framework).

The chosen service level greatly impacts the processes that are needed in order to implement the circular economy in a certain project, and therefore also impacts the organization that is needed in order to be able to deliver these services. This becomes clear through an explanation of figure S3, on the horizontal axis of figure S3 the different service levels are placed, the higher something is placed on the vertical axis, the more or higher it is. To illustrate the functioning of this graph consider the following; if a client or customer opts to acquire a product with basic- or intermediate services, the ownership of that product and therefore the circular responsibility will lay with the client or customer (as these represent the acquiring party). If on the other hand the client or customer opts to acquire a product through advanced services, the ownership will lay with the manufacturer or producer of that product, and hence the circular responsibility. When a client opts for more advanced services to establish circularity, the earlier described organizational ‘stretch’ might need to take place (depending upon the amount of available internal skills (Fang et al., 2008)). In cases of base- to intermediate services the implementation of sustainable concepts as it was found in other industries might suffice. With this graph the service level is always dependent upon the client, as is logical in a demand-driven economy.

Furthermore, under certain circumstances, an incentive shift alone might not be enough to ensure circularity. As redeppling products in another loop will only certainly be beneficial when resource prices are on a constant rise (as it would then be beneficial for the circular service provider to re-use installed resources instead of acquiring new resources). If resource prices therefore are not on a constant rise, additional agreements might have to be made between stakeholders to ensure circularity (even in advanced circular solutions). This observation links-up with the definition of the circular economy as it was introduced earlier in this research, and leads to the statement below:

‘Circular economy is a business strategy that, if governed correctly, is sustainable’

With respect to the construction industry it becomes clear that the service provider in a circular construction industry would need to: offer capabilities towards clients, change its relationships with suppliers, and needs to take note of a possible disappearance of scale benefits as they might be present now.

4. The business model prototypes

From the previous part it followed that there are different ways to deliver circular services (see figure S3). After consideration of these different levels, this research focuses on the service provider that delivers advanced services to the client. This will be done for several reasons:

1. An advanced services model is as of yet not present in the construction industry.
2. The literature review found that offering capabilities (which would occur through advanced services) show the greatest potential for profitability and sustainability gains (mainly through the previously described incentive shift).
3. In order to deliver circular products through base to intermediate services, the service provider needs to engage in similar activities as if it would offer advanced services. It would for instance still need to have an in-depth knowledge of its products and of the product capabilities to be re-introduced in another cycle at the end of its lifetime (in order to close at least one circle).
4. Examples in the construction industry where base- to intermediate services are offered are already present.
The product that the advanced services provider needs to offer can be described as follows:

The supply side needs to offer a performance that is supported by a service that optimizes said performance. The performance is based upon a delivered product (i.e. the building). The building is in part a collection of products that are interrelated at different scale levels. These products are delivered by the service provider, usually in combination with (different) supplying parties, but the service provider manages the overall performance.

In order for the service provider to be able to deliver this performance efficiently, several requirements need to be in place and several business operations need to be carried out by the service provider. Both the requirements and business operations follow from the literature review. The different requirements are:

• Behaviour of both client and supplier needs to change
• Performance should not be to specified by the client
• A tighter organization on the supply side’s part
• Decoupling points need to be incorporated in the used products
• Willingness, trust, and transparency are needed

The operations of the service provider follow from earlier sections of this research, and are:

• The service provider is responsible for the longer term and the different lifetimes
• The service provider is responsible for the lease with client
• The service provider needs to deal with the specific characteristics of the construction industry
• The service provider is responsible for picking the products / services
• The service provider needs to determine the building lifetime
• The service provider is responsible for checking the decoupling points

4.1 The business model framework
Nowadays there are different frameworks that can be used to design business models, this is mainly influenced by web-based companies that keep finding new ways to operate (Jonker, 2015). But not all of these frameworks might be equally appropriate to be used in this article, there are few frameworks that can be used for innovative and sustainable business models for example (Bocken et al., 2014). The business model prototypes under development in this article could be seen as innovative, as innovation can be defined as: ‘the successful launching of new, improved or more competing products, services or organization structures’ (Straub, 2011). Therefore the business model prototypes will be explained through the sustainable business model framework as presented in Bocken and Short (2015) that was introduced based on earlier research. It followed from Bocken et al. (2014) that the main elements of the business model are made up of the value proposition, that deals with the question what value is provided and to whom, value creation and delivery, that deals with the question how value is provided, and value capture that deals with the question how an organization generates income and captures other forms of value. The different variants presented in this research will all be built up of these three main elements and the underlying eleven sub-elements.

Perhaps surprisingly to some readers, the different variants and the models they contain do not focus on financial specifics in any specific way. While business models frequently (and sometimes for a large part) consist of financial calculations, the choice made in this research is to focus more upon organizational effects of a certain business model. A couple of arguments can be given for this choice:

• First, it was already established that the main challenge in implementing the circular economy in the construction industry is to be found at the organizational level. A finding that is confirmed for servitization in other industries through research done by Biege et al. (2012) and Windahl & Lakemond (2006).
• Second, contrary to popular belief and application business models are actually principally not about finances, this is merely the usual form of appearance or focus (Jonker, 2015).
• Thirdly it was found that, through the influence of the circular economy and service provision, more tailored, client-specific solutions are likely to occur. Therefore a financial model would also
have to be focused on a quite specific case. Apart from the fact that such a case does not yet exist in the construction industry, the goal of these business model prototypes is to develop a tool that is useful for all of the supplying parties in the construction industry. The addition of a financial model would narrow the focus of these models to specific cases. This would diminish the overall applicability of the prototypes, along this line of reasoning it can also be said that making these models more general would render them less useful.

It does however go without saying that the financial aspect of these variants is of major importance to any company that attempts to use them as a tool (Tukker, 2004). For these parties however, it should be relatively simple to couple their own (financial) situation to the different variants.

4.2 The business model prototypes
Now that also the business model framework has been chosen, all of the puzzle-pieces to design the business model prototypes are in place. It is chosen to create different variants as the lessons learnt do not point towards one single way in which the service provider can perform its business. First a description of the general business model prototype is presented, following the framework that was developed by Bocken and Short (2015). The largest part of this framework is valid for all of the developed variants. However, elements 7,9, and 10 of this prototype differ between the variants. As said these variants are based upon knowledge that was gained earlier in this research, and need to deal with the specific context that the construction industry provides for the service provider. In order to make this possible, the variants are built up on three variables (see figure S4):

- The first variable deals with the competences that are present within the organization of the service provider (as it follows from the literature study that a service provider should only pursue the offering of services in those areas that are part of its core business).
- The second variable is the earlier described organizational stretch.
- The third variable is the relationship with suppliers.

Therefore the first part of this section will introduce this general part of the business model prototype, following the framework as
Value Proposition

1. Product / service
   Housing that is completely tailored to the needs of the customer, at a certain performance, for a given time-period

2. Customer segments and relationships
   Broad segment with specific clients looking for a specific performance

3. Value for customer, society, and environment
   The customer receives tailored housing, society and the environment receive this in a sustainable manner

Value creation & delivery

4. Activities
   The service provider performs one, some, or all of the following: designing, building, financing, maintaining, operating

5. Resources
   The inherent knowledge the service provider has about the activities it performs

6. Distribution channels
   Can differ between service providers

7. Partners and suppliers

8. Technology and product features
   Non-toxic, pure materials of which the origins are known, supported by renewable energy. Also flexible, but the amount thereof is dependent upon the chosen model under point 7.

Value Capture

9. Cost structure and revenue streams

10. Value capture for key actors (incl. environment and society)
    variant 1
    fit for repetition, income stream, claim on materials
    variant 2
    (less) fit for repetition, income stream, claim on materials
    variant 3
    (less) fit for repetition, income stream, claim on materials
    variant 4
    (even less) fit for repetition, income stream, claim on materials
    variant 5
    income stream, claim on materials

11. Growth strategy / ethos
    Can differ between service providers

Figure S5: The five different business model prototypes with both the common and different aspects in the sustainable business model framework (source: own image, framework by Bocken & Short (2015))

*Financing as an activity always needs to be coupled with one of the other activities, in this model it cannot be the service provider’s only competence.
prototype including those elements that differ between the different variants, the reader is referred to figure S5.

Value proposition
Under the building block ‘value proposition’, three different topics are relevant; product/service, customer segments and relationships, and the value for customer society and environment. These different topics are the same for all the different variants and will be explained below.

1. Product/service
The service provider delivers housing for the client that is completely tailored to the client’s specific needs. The service provider also makes sure that these needs are met at a certain performance level throughout an upfront determined period of time (also see the definition of the product on offer).

2. Customer segments and relationships
The service provider is faced with a broad segment of clients looking for a specific performance. The relationship with the client is provider-specific, however since the service provider offers a tailored service it is important that the client is in close contact with the service provider.

3. Value for customer, society, and environment
The customer receives completely tailored housing, the value for society and environment can be found in the fact that the housing is delivered in a sustainable manner.

Value creation and delivery
The next building block of the framework of Bocken et al. (2015) is referred to as value creation and delivery. Five different topics are relevant here; activities, resources, distribution channels, partners and suppliers and technology and product features. These topics will be explained below. The topic ‘partners and suppliers’ (aspect number 7 in figure S5) is influenced by the three earlier introduced aspects and has therefore got five different variants.

4. Activities
The service provider performs either all of the following activities: designing, building, financing, maintaining, and operating, or (more likely) it performs one or more of these activities (if the service provider performs financing, this is always in combination with one of the other activities).

5. Resources
The service providers’ resource is the inherent knowledge it has about the activities it performs. This knowledge enables the service provider to deliver the agreed upon performance in an efficient way.

6. Distribution channels
The distribution channels are service-provider specific and will thus differ for each provider. This topic is therefore not worked out in more detail in the business model prototypes that are under development here.

7. Partners and suppliers
The relevant partners and suppliers can differ depending upon the chosen model. However the partners will always entail one or more of the following: the client, external suppliers and/or financiers. The client is a key partner because the product on offer here is housing that is completely tailored to the client’s needs, therefore the involvement of the client in this process is inevitable. The choice of the service provider to engage in an organizational stretch and/or lease-solutions with possible suppliers determines the model that is chosen.

8. Technology and product features
With regard to the product it can be said that it will be made-up of non-toxic, pure materials of which the origins are known. Furthermore the product will be flexible, the degree of which is dependent upon the choice under 7.

Value capture
The third building block of the business model framework deals with value capturing. Three different topics are introduced here; cost structure and revenue streams, value capture for key actors, and growth strategy or ethos.
These first two topics (topic numbers 8 and 9 in figure S5) are influenced by the three earlier introduced aspects and have therefore got five different variants.

9. Cost structure and revenue streams
   The exact structure and streams are dependent upon the choice under 7.

10. Value capture for key actors including society and environment
    The exact structure and streams are dependent upon the choice under 7.

11. Growth strategy / ethos
    The distribution channels are provider-specific and will thus differ for each provider. This topic is therefore not worked out in more detail in the business model prototypes that are under development here.

4.3 The relationship between the business model prototypes and theory

Figure S6 shows where the different variants of business model prototypes can be placed in relation to the circular economic service levels. Variants 1, 2, and 3 can be seen as directly emerging from circular economic theory as it was introduced and followed in in the introduction. These different variants place emphasis on the ‘right’ location of the incentive through not only risk-sharing (e.g., lease) solutions with clients, but also with upstream suppliers. Of these variants, number 1 has the clearest incentive as the service provider is solely responsible for delivering the agreed upon performance without any external suppliers. Variant two and three try to secure this incentive through risk-sharing solutions with suppliers as well as with clients, variant 2 adds an organizational stretch to this picture.

Variants 4 and 5 emerge from the findings in literature study, where it became clear that under certain circumstances it can be possible to have external suppliers who are not included in a risk-sharing agreement (see figure S3). Although this is a division from the circular economic theory as it was presented in earlier sections, examples from the literature study show that it is possible to operate in this way as long as the suppliers are monitored and commit themselves to agreed upon standards. In fact this way of operating is present within base to intermediate circular service solutions, the fact that the service provider still engages in risk-sharing solutions with the client however, makes that these solutions are still advanced services solutions.

As such, variant two shows good circular potential, but through the organizational stretch that is present in variant two the number of external parties is lower when compared to variant three. As such there are more potential scale benefits for the core-organization. However, variant two could entail a very large organizational stretch by the service provider (depending upon how many required skills for delivering the agreed upon performance are already present in the service provider’s organization), therefore for some parties this could not be the most probable variant to choose for. For both variants two and three, the dependence upon external suppliers is high, since there is a need to find additional suppliers that are willing to
perform in a similar way as the service provider (in order for the financial incentive to be in the correct place). However for variant two the amount of needed decoupling points could be quite low, improving its circular potential.

The earlier assumption (made following figure S6) that variants four and five are advanced services solutions but less theoretically pure, seems to be confirmed by table S1. The amount of external suppliers ranges from ‘fairly high’ to ‘high’, with a corresponding amount of decoupling points. The dependence on external supplier is lower when compared to variants 2 and 3 in the sense that these suppliers are not participating in a risk-sharing solution. These parties are however needed for the efficient execution of a project. For variant four, the same remarks about the organizational stretch can be made as under variant two. With these variants, scale benefits are not likely to occur due to the need to rely on external suppliers that are not involved in risk-sharing solutions, and therefore do not need to be as like-minded as the service provider when compared to the other variants. This will make the committed organization in principle only committed to the particular project that the particular organization is responsible for.

Although the service provider studied in these business model prototypes is a new entity, it can still be presumed that similar issues can be expected when it comes to financing a project. This is one of the consequences for choosing for advanced services, and would not appear when choosing for base- to intermediate circular services. However, as explained both the financial and sustainable benefits are potentially much greater with advanced services solutions, partly justifying the choice to develop these business model prototypes in this research. Furthermore, the variants offer a way around directly running into the financial obstacle through the ability of shifting the financial streams. This can be seen in the economic models that are part of the different variants, where use can be made of a financier in a similar way as in an energy saving company (ESCO) (Zhang et al., 2015). This also explains why finance is not one of the determinants behind the different variables for the variants (see figure S4), and why financial competences should always be combined with one of the other ‘DBMO’ competences (see figure S5). This as the position of the financier in these variants is not comparable to other supplying parties, since the definition of the product (or performance) on offer with advanced services is based upon an underlying product. Besides through engaging in ESCO-like arrangements, the financing issues could of course also be circumvented by a service provider that has sufficient capital means by itself.

As already stated above, it is questionable whether variant 1 can be found in the construction-industry any time soon due to the nature of the organization of the service provider. For the other variants this argument is less valid, however all parties do contain risk-sharing solutions with clients that are as of yet unprecedented in the industry. One can also wonder whether an organizational stretch is something that would occur in the near future. Therefore it can be questioned in

<table>
<thead>
<tr>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
<th>Variant 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of external parties</td>
<td>Low</td>
<td>Fairly low</td>
<td>Medium</td>
<td>Fairly High</td>
</tr>
<tr>
<td>Amount of decoupling points</td>
<td>Low</td>
<td>Fairly low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Dependence upon external parties</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Possible scale benefits</td>
<td>High</td>
<td>Fairly high</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Table S1: Comparison between the characteristics of the five different variants with variant 3 as a baseline (source: own table)
to what degree the models are readily applicable in the current construction industry.

5. Findings & Discussion
Four different parties were interviewed from different sections of the supply-side spectrum. This in order to get a wider view of this supply-side, it is important to add that all four companies are Dutch. One party’s core business entails maintenance provision for housing associations, another party is a medium-sized contractor, whereas the third party is a large-size contractor, and the fourth is a large-sized contractor/developer. Of these four parties, the large contractor/developer has got actual experience in a basic- to intermediate circular services project (Appendix M). The other larger contractor has been busy trying to implement circular economy into its building process waste stream. Both the medium-sized contractor and the maintenance provider have got no practical experience with the circular economy (but are familiar with the concept). It is however important to note that each actor has recently been busy realising either a sustainable or circular project that will be analysed in. When asked whether the circular economy could be seen as a potential business opportunity, all parties replied that this is, or could indeed be, the case. Subsequently to the interviews also some case studies were performed that looked at sustainable projects that were part of the activities of the interviewees. The goal here was to see to what degree these projects adhered to the circular economy as it was presented in this article.

5.1 Applicability of the business model prototypes
In general it can be stated that the respondents acknowledge the analysis made earlier on in this research, which resulted in a list of requirements and business operations for the service provider. Findings from the case studies however, suggest a minor addition to the business operation of ‘picking the right products and services’. Since the case studies show that it might also be beneficial to deliver advanced circular projects based on products. In effect this aspect shows that besides the necessity of offering of clear products towards clients in a circular economy, it might also be beneficial to base the entire delivery of a project on a clearly defined product as well.

However, as already was questioned, the business model prototypes are not readily applicable in today’s construction industry. For the interviewed parties a base- to intermediate model might be more fitting. This base- to intermediate model could be based upon service models as can be found in for instance the Tennet or Alliander case (see appendices F & M). It does need to be said that these base- to intermediate circular services models will most likely result in an incremental environ-mental gain instead of a radical environmental gain, as found by Tukker (2004). These models are however, as shows from the aforementioned interviews and case studies, already feasible in the construction industry of today.

In the long term however, the developed business model prototypes were seen as probable, although some variants might be more probable than others. It seems that variant 1 for instance is not seen as a probable model to be implemented by the interviewees. Even though it showed from analysis earlier that this model comes closest to the theory of the circular economy as it was outlined in this research. Next to variant 1, also variant 4 was not seen as a probable model throughout the interviews. It is hard to say what could be the reason for this, as variant two (also with an organizational stretch) was seen as probable by one of the respondents. Probably it comes down to the wish of the interviewees to tie the suppliers to the project with a lease-solution too, in that way ensuring that the suppliers are similarly incentivized. This could also be a reflection of the earlier system-based trust that is apparent in the construction industry.

Even though variant two was seen as probable (albeit by one party, with some serious considerations), it needs to be said that from the interviews both variants three and five were seen as more probable. A possible explanation for this can be found in the fact that of the developed variants, these two bear the highest amount of similarities with the current construction industry. Especially if these variants are realized through consortia they show a resemblance towards public-private-partnership constructions that are becoming more common in the construction
industry. A possible variant 5 solution (albeit without a consortium) can already be found in the Heijmans One case study, where the architect forms a supplier (for this to become an effective circular solution, the project would need to adhere to several additional requirements (see appendix L)). This shows that even though the interviewees do not regard the prototypes as presently feasible, they might be closer to real-world implementation than perceived.

5.2 Who picks up the role of the service provider?

The question as to what party would be able to pick up the role of the service provider remains somewhat unanswered. Should this indeed be a new entity in the construction supply chain or is one of the current parties suited to perform this role? Through the interviews it became clear that two contractors would perform as a service provider in the business model prototypes, whereas one contractor / developer seemed reluctant to adopt this role. The maintenance provider would prefer to be a supplier under the developed models. It would therefore seem that, first of all it depends on the personal preference of the parties whether they would act as a service provider or as a supplier. With the added notion that parties such as contractors, that are higher up the supply chain might see more chances to act as a service provider. A notion that does not hold to be true when compared with the literature review of this research, where it showed that the competences inherent in an organization determine the capability to act as a service provider. Therefore it is curious that parties like contractors and developers see themselves as fit to perform the role of the service provider as they reflect upon their own role as one of merely coordinating or assembling. However in the light of the fragmented supply chain it might also be these parties that are able to attract the needed competences the easiest, as this is part of their current operations already.

If these observations are combined with the findings that the interviewees have a preference for variant 3 and 5, and for operating in consortia, it becomes clear that the topic of vertical integration can be debated. In that case it would be more fitting to speak of quasi-vertical integration. Evidence provided by Oliva and Kallenberg (2003) also indicates that vertical integration is not likely to occur when companies that are already present in a certain industry start delivering services. Therefore if the service provider would not be a new entity, but instead be an existing party in the construction supply chain, this role would most likely be formed through a consortium of different parties. In this consortium, parties that are currently coordinating the building process might be best suited to perform a leading role (a de facto service provider). However, these leading parties would be heavily reliant upon external suppliers to obtain enough competences for the realization of the project. Which might make it difficult to deliver the agreed upon performance in an efficient way. Next to these observations, the costs that are associated with setting up a consortium can be quite high (Straub, 2007). It is therefore that the Dutch government generally does not enter into these contracts for projects that are worth less than €25 million (Rijksvastgoedbedrijf, 2012). Considering these aspects it seems that advanced circular services projects that are delivered through variants 3 & 5 with a consortium would therefore need to be of a considerable size.

However, variants 3 & 5 do not need to be realized through consortia, which is illustrated by the Heijmans One case for example. In that case the contractor was mostly responsible for the development and realization of the product, with some input from the architect. The architect in this case delivers design competences towards the project, but does this a supplier without any further ownership or incentivized connection towards the project (i.e. a variant 5 case). In such a case the amount of suppliers might be limited and therefore also the reliance upon these suppliers throughout the project could be limited. Arguably though, also the projects that could be carried out in this way might be smaller (but perhaps have the ability to be built in series). As this case study is not circular, a direct comparison is hard to make and either the architect or additional parties might be needed to be able to make this project circular. The degree to which the argument will hold that a consortium is not needed (or could be quite small), therefore still depends upon the internal competences of the service provider, as can also be seen from the Heijmans One example.
If on the other hand the service provider would be a new actor in the building supply chain, it can be questioned whether this actor would be bound to project realization through consortia as well. It could for instance be the case that an established company from another industry finds itself with all the needed competences to deliver a building through advanced circular services (or very specific competences that are as of yet absent in the construction industry). In such a case it can be doubted whether variants 3 and 5 would turn out to be the most relevant business model prototypes. Which variants will be the most relevant in that case is however not clear at this point. What is clear is that if the new actor would not be as dependent upon external suppliers as an existing actor, this could be an important advantage from a circular point of view.

5.3 Obstacles for the implementation of the prototypes

Despite seeing the variants as probable, the interviews showed some challenges that could limit this probability of use. Two of the biggest challenges that were identified through the interviews, were the financial and judicial circumstances under which the developed business model prototypes could function effectively.

This financial aspect is in line with the findings from the introduction, where it was presented as the second biggest challenge after the organizational problem. From the interviews it followed that in particular future financial uncertainty is of concern. Stigter’s (2016) findings deal with this uncertainty and show that the profitability of circular lease-solutions is mostly dependent upon resource price levels. Thereby also acknowledging the statement as it was made in the literature study that the circular economy does not need to be sustainable under situations where resource prices are not increasing. Furthermore Stigter’s (2016) research states that a ‘substitution risk premium’ is needed in order to accurately model the costs of a lease-solution for building materials. The underlying reasoning for this premium follows concerns about the ability of certain products to be redeployed in another loop. This shows that this is a factor to be reckoned with, however Stigter’s research also shows that the substitution risk premium does not affect the internal rate of return of a lease-solution in a more pronounced way than any of the other modelled risk premiums.

Legal uncertainty was found as an obstacle through interviews with two actors that are already involved with implementing or comprehending the circular economic concept and one that is as of yet not doing so. The judicial uncertainty affects two different aspects; first, under current legislation it is hard to prescribe separate rules and owners for different building components, as regulations generally affect buildings as a whole. Second, under the influence of progressing legislation over time it becomes hard to determine whether a component that is produced now, will still be fit for use in the future (thereby the legal argument also contributes to the substitution risk and the height of its premium). These are valid points of concern that previously were not considered to this depth, but are not investigated further here as they are beyond the scope of this research. What can be said is that the legal uncertainties might decrease for the following three reasons:

1. The product or project under development involves few stakeholders, in this way the amount of connecting point may decrease (prototype variant 1 would even further diminish this uncertainty).
2. Also a new-built project might have an edge over a renovation project when it comes to the amount of legal uncertainty, as with a new-built project fewer connections and or de-coupling points might be necessary with an existing structure and coupled stakeholders.
3. Thirdly, flexibility in the design to accommodate for future changes in regulation (although these might be unknown) might increase the ability of (parts of) a project to be redeployed in other loops.

These three aspects might reduce the legal uncertainty, and thereby part of the substitution risk premium.

Furthermore limiting the immediate applicability of the business model prototypes is market demand. From the interviews it followed that there is a need for a clear
market demand for the implementation of these models, which is as of yet not present in the construction industry. This confirms the findings made by Loppies (2015) stating that the ‘right’ demand needs to be present in order to realize the circular economy. However it also followed from the interviews that this market demand is expected to manifest itself in the future, and it can be as simple as one client asking for a circular project in order for the models to become relevant. Also projects like that of Tennet and Alliander (Appendices F & M) show that market demand (albeit for base- to intermediate circular services) is starting to appear. To what degree market demand will manifest itself for advanced circular services remains, as of yet, unclear. As follows from the circular services level framework, sustainability can also be guaranteed through other than advanced circular services solutions. Therefore, sustainability alone would not be enough motivation to enter into advanced services circular solutions. When a look is given at cases researched by Baines and Lightfoot (2013), it seems that the outsourcing of risk is the main reason for a company to enter into advanced services. When translated to the construction industry, this would mean that market demand for advanced circular services is most likely to arise with parties whose housing needs are uncertain over longer periods of time (e.g. parties entering a new market, parties operating in volatile markets, or parties that cannot afford the initial investment costs associated with housing). Examples of parties that would demand these services therefore could be; parties that deal with a temporary demand, new businesses (start-ups), and/or businesses that need to be on a particular location for the duration of a particular contract.

It also became clear that as suspected, innovation is needed in several sections of the construction industry in order for the business model prototypes to become effective.

5.4 A roadmap for an advanced circular service provider
The input for this roadmap is provided by section 4 where the requirements, business operations, and different variants of prototypes were presented. However after the foregoing findings and discussion some minor changes and additions can be made to this information. Also a certain order in the requirements and business operations can be suggested, this has resulted in a roadmap that is presented in this section.

1. The circumstances meet the requirements as set out in section 4.
2. The supplying party is willing to deliver advanced circular services, and expects resource prices to rise in the future.
3. After these requirements are met, the service provider starts with determining the lifetime of the building, which is dependent upon the length of the contract with the client.
4. The service provider picks (process-based project delivery) or develops (product-based project delivery) those products that are able to meet the agreed upon performance. Both process-based and product-based project delivery are viable options for the service provider to take, they do however come with their own set of characteristics.
5. The service provider needs to deal with the specific characteristics of the construction industry and needs to check the decoupling points.
6. The service provider takes on the operational responsibilities regarding the lease during the contract period.
7. The service provider makes sure the used products are redeployed at the end of the contract or at an end-of-loop situation.

5.5 Consequences for the different stakeholders in the current construction industry
As the whole concept of a service provider and the different variants are quite abstract, this section will offer a perspective on the relation between the advanced circular service provider and the current stakeholders in the construction industry. Thereby essentially clarifying the answer to the second part of the main research question. In order to do so, the consequences that the delivery of advanced circular services might have on the current construction industry stakeholders are mapped in the table below (table S2). These consequences follow the findings done in this research, and with acknowledgement that this question remains somewhat unanswered through this research, they therefore form a (controlled) prediction.
Through table S2 it becomes clear that there is still a lot of uncertainty surrounding the effects of a choice for variant 1 on the current stakeholders in the construction industry. Variant 1 is included in this overview for reasons that were stated at the outset of this section and will, according to the findings, only appear in the form of an external stakeholder venturing into the construction industry. The fact that the stakeholder is as of yet not present in the construction industry, explains part of the uncertainty about the consequences on the current stakeholders. What can be said is that the position of the user will remain unchanged when compared to the position in figure S1. Also the ‘traditional owner’ will disappear, as the service provider will retain ownership of the delivered products. This will make the role of the traditional owner redundant (this holds for all of the developed variants in this research, so not merely for those depicted in table S2). Furthermore the financier will either disappear in the case where the service provider has enough financial means to effectively operate the lease solution or the financier will become the recipient of the income stream during the duration of the contract. Since in a variant 1 case it is assumed that the service provider has got all of the needed competences within its own organization, this would mean that all of the other stakeholders in the construction process are no longer needed.

For both variant 3 & 5 the same consequences can be expected for the current stakeholders in the construction industry depending if the services are delivered through a consortium or not. When variant 3 & 5 are conducted through a consortium, the main contractor will most likely be part of this consortium because of its capabilities to attract competences to the project. If the consortium is absent however it can be questioned whether the main contractor will be of any use if its only capability lies in the gathering of competences. Therefore if the main contractor does not possess any of the needed competences other than gathering these, this...
stakeholder will disappear out of the process. The same thing can be said for the project developer, also with this stakeholder more competences are needed than just the ability to gather those needed for the project in a situation where no use is made of a consortium in variants 3 and 5. Both a supplier and specialist would retain their role as a supplier in case no consortium is used in a certain project. If a consortium is used these parties could either be a supplier or, depending on the matter of impact of the product they offer, part of the service-providing consortium. A sub-supplier will in all cases displayed in table S2 arguably become a supplier in the form of a product or industrial designer, or in the form of a composer of the needed products for the agreed upon performance if the service provider lacks overall design competences. This is because of the nature of the design that is needed in an advanced circular construction industry, which focuses on products. Lastly, the role of the facility manager will disappear completely in its current form (in all of the variants), as the service provider (and possibly those suppliers connected to the service provider with an incentivized contract) will fulfill the operations that are traditionally performed by this actor.

Conclusions
This report introduced five different business model prototypes based upon the inherent knowledge of parties on their competences in the construction industry. These business model prototypes were developed following an extensive literature review and focused solely on advanced circular services solutions. This was done for two reasons: first this type of business model is as of yet unknown in the construction industry (as can be seen from the circular service level framework). Second, this type of business model can be expected to deliver radical environmental gain. With the development of these business model prototypes the first part of the research question is answered.

In general the interviews found that the developed business model prototypes are not seen as directly applicable in the construction industry, on the long term however they were seen as probable. While the interviewees showed some convincing arguments as to why they perceive these prototypes as not directly applicable (see the obstacles that are explained below), from the case studies some examples came forward that go a long way in circularity. It can therefore be argued whether the prototypes are really as unfeasible in the short run as the interviewees believed.

With regard to the second part of the research question, the findings indicate that there is no definitive answer to be found yet. First of all it seems to depend upon the personal preference of the supplying parties whether they would act as a service provider or as a supplier. With the added notion that parties such as main-contractors or developers that have a coordinating role in today's construction industry might be closer to perform the role of the service provider in case use is made of a consortium. Although this task does not call for many of the identified competences, in the light of the fragmented construction supply chain it might also be these parties that are able to attract the needed competences the easiest, as this is part of their current operations already.

From the map of consequences for the different stakeholders it became clear that the choice for or against a consortium could have significant consequences for the current stakeholders in a construction project. Also the entrance of an external party with a high degree of competences could therefore have a profound impact on the current construction industry.

Given the fact that the developed business model prototypes are (arguably) not likely to be implemented in the short-term, the implementation of the circular economy would likely be restrained to basic-, to intermediate services business models. Evidence of which can already be found in the current construction industry, as can be seen from some of the examples introduced in this research. This will most likely limit the environmental gain by implementing the circular economy in the construction industry to an incremental level.
Samenvatting (Dutch summary)

At your service!
Circulaire businessmodelprototypen voor een service provider in de bouwindustrie

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Abstract
De afgelopen jaren heeft de circulaire economie veel aan aandacht gewonnen, echter blijft praktische implementatie van het concept veelal nog uit. Vooral in de bouw- en verkeerd - industrie is er behoefte aan een praktische vertaling van het concept. Dit onderzoek maakt deze vertaling door de gezamenlijke ontwikkeling van zowel theorie omtrent de circulaire economie als businessmodelprototypen ten behoeve van de bouwindustrie. Deze prototypen zijn toegespitst op service providers in de bouwsector omdat uit literatuuronderzoek blijkt dat deze partij onontbeerlijk is in de ontwikkeling van de circulaire economie in deze specifieke bouwsector. Met deze focus op twee verschillende vlakken wordt antwoord gegeven op de volgende vragen; hoe moet een service provider zich organiseren aan de hand van de circulaire economie en ten tweede, hoe verhoudt deze service provider zich met de huidige stakeholders in het bouwproces?

Kernwoorden:
Circulaire economie, service provider, business model prototype, gebouwde omgeving, bouwsector

Deel 1: Onderzoeksopzet
Dit deel van het rapport introduceert de onderzoeksopzet. Onder andere de motivatie achter dit onderzoek, de probleemstelling, onderzoeksrelevantie, onderzoeksvragen en het onderzoeksdoel komen aan bod.

 Waarom de circulaire economie bestuderen?
Circulaire economie biedt een nieuw perspectief op de gang van zaken in vele industriën, zodat de bouw- en verkeerd - industrie. In theorie zou de circulaire economie deze iets fortisfivatie sector significan kunnen veranderen. Om deze reden is het de verantwoording van de auteur dat het een onderwerp is dat de moeite waard is om te bestuderen.

Probleemstelling en onderzoeksvragen
Na een onderzoek naar zowel de circulaire economie als de bouwsector is er een poging gedaan deze twee werelden met elkaar te verenigen. In dit proces kwamen verscheidene obstakels aan het licht, verder onderzoek naar deze obstakels wijst uit dat deze zich concentreren rond een organisatorisch probleem. Dit organisatorische probleem berust voornamelijk op een schaalprobleem dat ontstaat doordat de verschillende stakeholders in het bouwproces verschillende belangen hebben. Om de verschillende belangen, gecombineerd met andere bevindingen omtrent de circulaire economie maken duidelijk dat het geconstateerde schaalprobleem in een circulaire bouwsector niet zal worden opgelost door de circulaire economie te implementeren met de huidige organisatie in het bouwproces (de hele analyse is te vinden in hoofdstuk 4).

Om de circulaire economie succesvol te kunnen implementeren in de bouwsector is daardoor een nieuwe actor nodig, de service provider. Deze service provider (die wellicht

Daardoor biedt dit onderzoek, zoals hierboven uitgelegd, de mogelijkheid om een (geïdealiseerde) circulaire bouwindustrie te bestuderen, zonder daarbij te worden gehinderd door de obstakels zoals die er nu zijn. Daartoe vormt de service provider de basis voor het leggen van de juiste prikkel bij de juiste stakeholders zoals dat in dit onderzoek wordt geïntroduceerd. Daarmee is de probleemstelling van dit onderzoek als volgt: ‘een organisatie van de service provider op zo’n wijze dat deze zich verhoudt tot de definitie en de principes van de circulaire economie en hoe deze organisatie zich verhoudt tot de huidige actoren in het bouwproces’ Op basis van deze probleemstelling kan een tweeledige onderzoeksvraag worden opgesteld: ‘Hoe kan de service provider op zo’n wijze worden georganiseerd dat zijn rol zich verhoudt tot de definities en principes van de circulaire economie’ en ten tweede: ‘Hoe verhoudt deze organisatie van de service provider zich tot de huidige actoren in het bouwproces’

Het onderzoeksresultaat
Het onderzoek levert een resultaat op in de vorm van verschillende businessmodel-prototypen die inzicht en/of oplossingen bieden voor de nieuwe context waarmee de aanbodzijde van de bouwindustrie geconfronteerd wordt onder invloed van de circulaire economie. Hiertoe worden verschillende varianten van deze prototypen ontwikkeld, omdat het literatuuronderzoek niet wijst naar een eenduidige manier waarop met deze nieuwe context kan worden omgegaan. Elke variant zal worden gepresenteerd met gebruik van het raamwerk dat is ontwikkeld door Bocken & Short (2015). Dit businessmodelraamwerk levert richtlijnen voor het ontwikkelen voor nieuwe businessmodellen, daarnaast toont het de verschillende relaties aan tussen stakeholders en hun middelen. Door het gebruik van dit raamwerk zal duidelijk worden op welke manier de service provider zal functioneren in een circulaire bouwindustrie.

Onderzoeksrelevantie
Dit onderzoek is relevant op drie verschillende vlakken, te weten; wetenschappelijk, maatschappelijk en praktisch vlak. Dit onderzoek is wetenschappelijk relevant omdat huidige literatuur omtrent de circulaire economie vaak blijft hangen op een abstract niveau. Hierdoor is het moeilijk om de circulaire economie te verbinden aan bijvoorbeeld; mensen, bedrijven, projecten, processen en bedrijfssectoren (Ellen MacArthur Foundation, 2014; Van Dijk et al., 2014; Antink et al., 2014; Kok et al., 2013; Mentink, 2014; De Grauw, 2015). Er is dus een behoefte aan literatuur die de praktische implementatie van de circulaire economie duidelijk maakt, verder onderzoek wijst uit dat deze situatie ook voor de bouwindustrie geldt. Hoewel er recent aan de faculteit bouwkunde van de TU Delft verscheidene onderzoeken naar de circulaire economie zijn afgerond, richt geen één van deze onderzoeken zich expliciet op de circulaire service provider vanuit het perspectief van de aanbodzijde van de markt. Daarmee is dit onderzoek uniek omdat (1) de circulaire service provider in de bouw wordt onderzocht vanuit het perspectief van de aanbodzijde en (2) omdat dit onderzoek wordt uitgevoerd vanuit een zorgvuldig opgebouwd, kritisch geëvalueerd theoretisch raamwerk dat daarna weer gekoppeld wordt aan de praktijk. Er is dus een behoefte aan literatuur die de praktische implementatie van de circulaire economie duidelijk maakt, verder onderzoek wijst uit dat deze situatie ook voor de bouwindustrie geldt.
Dit onderzoek is maatschappelijk relevant omdat de potentiele effecten van de circulaire economie op de maatschappij van aanzienlijke grootte kunnen zijn. Zo schatten Bastein et al. (2013) in dat de circulaire economie in Nederland de potentie heeft om 54.000 banen te scheppen en €7,3 miljard euro aan besparingen. Hoewel de accurate waarde van deze cijfers betwist kan worden, omdat deze voornamelijk afhangt vanuit welk oogpunt naar de circulaire economie wordt gekeken, zou de maatschappelijk impact zelfs bij een halvering van deze cijfers nog aanzienlijk zijn. Naast het scheppen van banen en het realiseren van besparingen biedt de circulaire economie ook de kans om de hoeveelheid afval drastisch te verminderen.

Ten derde is dit onderzoek praktisch relevant omdat de uitkomst (businessmodelprototypen red.) partijen aan de aanbodzijde van de bouwindustrie handvaten geeft om de circulaire economie in te richten voor hun eigen bedrijfsprocessen. Zo kunnen de prototypen bijvoorbeeld worden aangewend als onderdeel van een business plan (bijvoorbeeld naar Osterwalder & Pigneur, 2010) of kunnen deze worden gebruikt voor het ontwikkelen van toekomstscenario’s (bijvoorbeeld naar Lindgren & Bandhold, 2003). Op deze manier zijn de uitkomsten van dit onderzoek te gebruiken door alle partijen aan de aanbodzijde van de bouwindustrie en vormen het de eerste businessmodelprototypen voor een circulaire service provider vanuit het perspectief van de aanbodzijde van de markt.

Deel 2: Literatuuronderzoek
Het tweede deel van dit onderzoek richt zich op literatuur onderzoek en vormt zo het theoretische onderdeel. Aspecten die in dit deel voorbij komen zijn: de circulaire economie in het algemeen, de bouwindustrie in het algemeen, een onderzoek naar een circulaire bouwindustrie, het aanbieden van services in andere industrieën en de implementatie van andere duurzame concepten in andere industrieën.

De circulaire economie in het algemeen
De circulaire economie stelt een verandering voor van lineaire consumptie naar circulaire consumptie. Op deze manier poogt de circulaire economie het aantrekkelijker te maken voor producenten om duurzame producten te maken die meerdere ‘kringlopen’ kunnen doorlopen. Beter gezegd, in een circulaire economie is het in het belang van de producent zelf om producten op deze wijze te produceren omdat de producent verantwoordelijk zal blijven voor zijn eigen product in plaats van de consument. Dit geeft meteen het belangrijkste verschil aan tussen de circulaire economie en andere duurzame concepten als bijvoorbeeld cradle-to-cradle. Een duurzamere wereld is in een circulaire economie meer het gevolg van een prikkelverschuiving (volgens bovenstaand mechanisme) in plaats van het directe doel.

Het concept circulaire economie zoals het wordt gepresenteerd door de Ellen MacArthur Foundation zou echter niet één op één overgenomen moeten worden. Zo is het bijvoorbeeld, door de huidige staat van de literatuur, onmogelijk om één algemeen geaccepteerde definitie van de circulaire economie te geven. Daarnaast wordt de circulaire economie in huidige literatuur beschreven volgens een bepaalde hiërarchie
zonder dat deze als zodanig wordt onderkent. Daarnaast zijn er nog onzekerheden omtrent bijvoorbeeld levensduurverlenging, de mate van duurzaamheid van deze actie is niet geheel duidelijk. Ditzelfde geldt voor het proces van downgrading. Bovendien zou moeten worden onderkent dat een circulaire economie vanwege praktische bezwaren nooit helemaal 100% circulair kan zijn, maar dat een circulaire economie daar wel zo dicht mogelijk bij in de buurt zou moeten proberen te komen. Het laatste punt dat met betrekking tot dit aspect uit de literatuur naar boven komt is dat de huidige theorie omtrent het concept geen houvast biedt waar het gaat om het behoud van eigenaarschap over ingebrachte materialen.

Omdat er nog geen algemeen geaccepteerde definitie van de circulaire economie is, wordt in dit hoofdstuk uitgegaan van een eigen definitie (gebaseerd op huidige literatuur). Deze definitie luidt als volgt: ‘een circulaire economie is een economisch systeem met cyclische materiaalkringlopen gebaseerd op een financiële prikkel’. Daarnaast zijn er bepaalde randvoorwaarden opgesteld die rondom deze definitie aanwezig moeten zijn om meer houvast te geven voor dit onderzoek.

De bouwindustrie

De huidige bouwindustrie wordt gekenmerkt door zijn project gedreven aanpak, waarbij elk project unieke producten (gebouwen) aflevert. Door deze mate van uniciteit is elk project ook daadwerkelijk anders, waarbij in elk project andere stakeholders deelnemen. Verder wordt er doorgaans niet nagedacht over wat er gedaan dient te worden in een situatie waarin een gebouw aan het einde van zijn levensduur is. Dit komt waarschijnlijk door de relatief lange levensduur van gebouwen. Verder is er ook niet één levensduur van een gebouw aan te wijzen omdat elke gebouwcomponent zijn eigen levensduur heeft. Verder is de sector kapitaalintensief en steunt veelal op handwerk.

In een poging om de bovenstaande karakteristieken van de industrie te veranderen, zijn er verscheidene poging gedaan tot partnering binnen de bouwindustrie. Partnering zou namelijk moeten leiden tot verhoogde effectiviteit en efficiëntie, commercieel succes, een verbetering van de prestatie van de deelnemende bedrijven en een beter eindproduct. Binnen de bouwindustrie is partnering meestal vastgelegd door middel van contracten. Op deze manier vormen contracten een partnerschap tussen de klant en de verantwoordelijke partij aan de aanbodzijde, maar laten ze elke mogelijkheid tot partnering tussen de andere aanbiedende partijen open. Mede hierdoor kan de korte termijnfocus van de industrie worden verklaard. Een ander gedeelte van deze korte termijnfocus kan worden toegeschreven aan de grote invloed van de klant op het bouwproces. Ondanks dat de klant mede debet is aan deze korte termijnfocus schrijft de literatuur hem een grote rol toe in partnering in de bouwindustrie. Waarschijnlijk ligt hier echter het gebrek aan een zogenoemde ‘focal firm’ aan de aanbodzijde aan ten grondslag, waardoor partnering in de bouwindustrie bemoeilijkt wordt.

De bouw en de circulaire economie

Door middel van drie korte oefeningen wordt de praktische uitwerking van het toepassen van de circulaire economie (zoals hierboven beschreven) op de bouwindustrie (zoals hierboven beschreven) duidelijk. Vanuit deze korte oefeningen kan worden geconcludeerd dat wanneer de circulaire economie wordt toegepast in de bouw, het verschil tussen vraag- en aanbodzijde in de industrie verwaagt. Daarnaast verandert de lengte van de betrokkenheid van verschillende stakeholders. Wanneer werd gekeken naar bedrijfsfinanciering werd duidelijk dat het voor het toepassen van de circulaire economie is om eigenaarschap van zijn producten te blijven van zijn producten vanwege de betrokkenheid van verschillende stakeholders. Ondanks dat de klant mede debet is aan deze korte termijnfocus schrijft de literatuur hem een grote rol toe in partnering in de industrie. Door middel van drie korte oefeningen wordt de praktische uitwerking van het toepassen van de circulaire economie (zoals hierboven beschreven) op de bouwindustrie (zoals hierboven beschreven) duidelijk. Vanuit deze korte oefeningen kan worden geconcludeerd dat wanneer de circulaire economie wordt toegepast in de bouw, het verschil tussen vraag- en aanbodzijde in de industrie verwaagt. Daarnaast verandert de lengte van de betrokkenheid van verschillende stakeholders. Ondanks dat de klant mede debet is aan deze korte termijnfocus schrijft de literatuur hem een grote rol toe in partnering in de industrie. Door middel van drie korte oefeningen wordt de praktische uitwerking van het toepassen van de circulaire economie (zoals hierboven beschreven) op de bouwindustrie (zoals hierboven beschreven) duidelijk. Vanuit deze korte oefeningen kan worden geconcludeerd dat wanneer de circulaire economie wordt toegepast in de bouw, het verschil tussen vraag- en aanbodzijde in de industrie verwaagt. Daarnaast verandert de lengte van de betrokkenheid van verschillende stakeholders. Ondanks dat de klant mede debet is aan deze korte termijnfocus schrijft de literatuur hem een grote rol toe in partnering in de industrie. Daarnaast liggen er uitdagingen aan ten grondslag, waardoor partnering in de bouwindustrie bemoeilijkt wordt.

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Het vinden van de juiste circulaire prikkel in de bouw

Na het vaststellen van de obstakels in de voorgaande delen van het onderzoek rijst de vraag op welke manier de circulaire economie kan worden toegepast in de bouwindustrie. Ten eerste zou de bouwindustrie producten moeten aanbieden die het mogelijk maken om een bepaalde prestatie of service aan de klant aan te bieden. In dit onderzoek wordt voor die prestatie de volgende definitie gebruikt: ‘een prestatie is een overeengekomen actie tot presteren die resulteert in een uitkomst, utiliteit, doel, functie of toezegging, waarbij het product het doel zelf niet is, maar een randvoorwaarde voor de prestatie (naar De Grauw, 2015)’. Daarbij is een service; ‘een voornamelijk non-fysieke actie of proces waarbij de prestatie wordt geoptimaliseerd over een langere periode (naar De Grauw, 2015)’. Deze twee definities leiden op hun beurt tot een veranderde definitie van een gebouw; ‘een verzameling van producten die tezamen een entiteit vormen die kan worden beschreven als een gebouw. Een gebouw is daardoor een verzameling van gecombineerde producten en/ of services op verschillende schaalniveaus (naar Prins, 1992)’.

Ten tweede wordt duidelijk dat het eerder geïdentificeerde organisatorische probleem zijn oorsprong vindt in een schaalprobleem. Daarnaast wordt duidelijk dat dit schaalprobleem niet eenvoudig op te lossen is door eigenaarschap toe te bedelen aan één van de huidige stakeholders in het proces.

Daarom is het noodzakelijk dat, om de circulaire economie succesvol te kunnen implementeren in de bouwindustrie, een nieuwe actor in het bouwproces wordt opgenomen, de service provider. Deze service provider (die wellicht alleen om onderzoektechnische redenen zal bestaan) zou een duidelijke, zogenaamde focusactor voor de aanbodzijde in de bouwindustrie kunnen zijn, waarmee bestaande barrières kunnen worden weggewoond. Deze nieuwe entiteit geeft daardoor de mogelijkheid tot het bestuderen van een (geïdealiseerde) circulaire bouwindustrie, zonder daarbij te worden gehinderd door de obstakels zoals die er nu zijn. Nu is het idee van een service provider niet nieuw, sterker nog de Ellen MacArthur Foundation (2012) gebruikt deze al in het door hun voorgedragen concept. De service provider zoals deze in dit onderzoek wordt voorgesteld verschilt echter wezenlijk van de service provider die door de Ellen MacArthur Foundation (2012) wordt geïntroduceerd. In dit onderzoek worden namelijk de bedrijfsprocessen en relaties van de service provider onderzocht, terwijl deze in het model van de Ellen MacArthur Foundation (hoewel onduidelijk gedefinieerd) als vast worden aangenomen, waardoor er voorbij wordt gegaan aan de noodzaak van dieper onderzoek naar hoe deze rol zich zou moeten vormen.

Lessen vanuit andere industrieën

Omdat is vastgesteld dat voor een effectieve implementatie van de circulaire economie in de bouw een service provider nodig is, wordt in deze paragraaf gekeken naar hoe deze rol wordt ingevuld in andere industrieën. Voornamelijk omdat deze actor in de bouwindustrie, zoals eerder is vastgesteld, nog niet aanwezig is. Daarnaast wordt gekkeken naar de implementatie van duurzame concepten in andere industrieën. Eventuele lessen uit beide onderdelen zullen vervolgens worden gebruikt om gestalte te geven aan deze rol in de bouw.

Wat ten eerste duidelijk wordt is dat er een onderscheid gemaakt dient te worden tussen zogenaamde ‘pure service providers’ en ‘producerende service providers’, waarbij de laatste vorm het meest aansluit bij het circulaire economieconcept. Daarnaast ontstaan deze service providers (die de circulaire economie overigens niet implementeren) voor de volgende redenen; een economische reden, een milieureden, een marktreden, een technologische reden en een kennisreden. Nadere uitleg rondom deze redenen laat duidelijke parallellen zien met de circulaire economie zoals deze in dit onderzoek is gepresenteerd. De hoofdreden voor bedrijven om zich als service provider op te stellen komt voort vanuit de economische reden. Verder valt op dat verschillende services verschillende kansen bieden met betrekking tot het duurzame potentieel. Deze verschillende services zijn in te delen in drie niveaus; basis, gemiddeld en gevorderde services. Hierbij zouden gevorderde services het grootste potentieel op milieuverbetering hebben.

Daarnaast zijn deze gevorderde services het best te verenigen met de circulaire economie zoals deze in dit onderzoek wordt uitgelegd.
Deze gevorderde services worden geleverd door middel van een product-servicesysteem waarbij de fabrikant zich moet richten op; (1) de mogelijkheid om kosteneffectief te reageren en (2) de mogelijkheid om kosteneffectiviteit te verbeteren. Om deze mogelijkheden te kunnen beheersen zal de fabrikant in sommige gevallen zijn organisatie moeten ‘rekken’. Hierbij moet de fabrikant uitkijken niet te dicht op de core-business van de klant te gaan zitten en tegelijkertijd uitkijken om zijn leveranciers niet in de weg te gaan zitten. Hoewel de vergelijkings-industriën waarin deze service providers zijn gevonden verschillend zijn van de bouw-industrie, zijn er ook bepaalde overeenkomsten te vinden. Zo zijn al de vergelijkings-industriën gevestigde sectoren met homogene producten, waarin deze service providers zichzelf proberen te onderscheiden door het leveren van services.

Verschillende casestudies maken duidelijk waarom bedrijven in andere industrieën er voor kiezen om volgens een duurzaam concept te opereren. In elk van deze cases is het bedrijf in kwestie op zoek naar een manier om de eerder beschreven financiële prikkel op de juiste manier te integreren in de bedrijfsvoering. Hoewel de bestudeerde bedrijven er andere ideeën wat betreft duurzaamheid op na houden, zijn er wel bepaalde gezamenlijke elementen terug te vinden in de bedrijfsvoering als gevolg van de duurzame bedrijfsvoering. Zo houdt elk bestudeerd bedrijf zich bezig met actief ketenmanagement en het leveren van services gebaseerd op de geleverde producten. Verder worden de geproduceerde producten in twee van de drie gevallen gemonitord wanneer deze door de klant in gebruik zijn, zodat deze zeker de afgesproken prestatie behalen.

Daarnaast bevinden de bestudeerde bedrijven zich (net als bij de service providers eerder) in gevestigde sectoren met homogene producten, waarin deze bedrijven zichzelf proberen te onderscheiden door het leveren van duurzame producten.

Er kunnen verschillende lessen worden geleerd op basis van de twee bovenstaande studies met betrekking op een circulaire bouwindustrie. Ten eerste zijn er meerdere manieren waarop de circulaire manier kan worden ingericht (figuur DS1). De gekozen manier is afhankelijk van de service die de klant wenst te ontvangen bij een bepaald product, dit kan een basis, gemiddelde, of gevorderde service zijn (waarbij gevorderde services het meest overeenkomen met de circulaire economie zoals deze in dit onderzoek is gepresenteerd). Het gekozen serviceniveau heeft vervolgens een grote impact op de bedrijfssystemen die nodig zijn voor het implementeren van de circulaire economie in dat bepaalde project. Dit heeft daardoor ook impact op de organisatie die nodig is om deze services te leveren. Daarnaast zal het onder sommige omstandigheden niet genoeg zijn om alleen de ‘prikkel’ te verleggen om circulariteit te borgen. Verder wordt duidelijk dat een service provider in de bouwsector de volgende aspecten zou moeten meenemen in de bedrijfsvoering; het aanbieden van mogelijkheden naar klanten, het veranderen van de verhoudingen met leveranciers en het rekening houden met het mogelijk verdwijnen van bepaalde schaalvoordelen voor zover deze nu aanwezig zijn in de bouw.

Deel 3: Businessmodelprototypen
Het derde deel van het onderzoek richt zich op het ontwerpen en valideren van
verschillende businessmodelprototypen, het vormt daarmee het praktische deel van het onderzoek. Aspecten die in dit deel aan de orde komen zijn onder andere; het daadwerkelijke ontwerp van de prototypen, een discussie op basis van de bevindingen van de interviews, enkele casestudies en een vergelijking met ander onderzoek gericht op de circulaire economie.

Het ontwerp van de businessmodelprototypen

Zoals eerder uitgelegd zijn er verschillende mogelijkheden om circulaire services aan te bieden. Na afweging zal dit onderzoek zich richten op de service provider die gevorderde services aanbiedt. De volgendeaspecten spelen in deze keuze mee:

1. Een gevorderd service model is tot op heden nog niet aanwezig in de bouwindustrie.
2. Vanuit het literatuuronderzoek volgt dat het aanbieden van mogelijkheden en of uitkomsten het grootste winstpotentieel (zowel financieel als milieu) bevatten.
3. Wanneer een service provider kiest voor basis of gemiddelde services moet nog steeds worden geopereerd volgens vergelijkbare activiteiten dan wanneer er gekozen wordt voor gevorderde services.
4. Er zijn in de bouwindustrie al enkele voorbeelden te vinden van basis en gemiddelde services.

Het product dat deze gevorderde service provider moet aanbieden aan de klant kan als volgt beschreven worden; ‘een prestatie die wordt ondersteunt door een service die de prestatie optimaliseert. De prestatie is gebaseerd op een geleverd product (een gebouw). Het gebouw is op zijn beurt een verzameling van producten die op verschillende schaal niveaus met elkaar gekoppeld zijn. Deze producten worden geleverd door de service provider, naar alle waarschijnlijkheid met andere leveranciers, maar de service provider is verantwoordelijk voor de geleverde prestatie.’ Om het voor de service provider mogelijk te maken om zijn services op een efficiënte manier aan te bieden moet er aan verschillende randvoorwaarden worden voldaan. Daarnaast moet de service provider zich bezig houden met bepaalde bedrijfsprocessen. Zowel de randvoorwaarden als processen komen voort uit het literatuuronderzoek. De verschillende randvoorwaarden zijn:

- Het gedrag van zowel klant als aanbieder moet veranderen
- De gevraagde prestatie moet niet te gespecificeerd worden door de klant
- Een strakkere organisatie aan de aanbodzijde is nodig
- De ontkoppelpunten moeten aanwezig zijn in de gebruiktte producten
- De wil, het vertrouwen en transparantie moeten aanwezig zijn

De verschillende bedrijfsprocessen van de service provider zijn:

- De service provider is verantwoordelijk voor de langere termijn en de verschillende levensduren
- De service provider is verantwoordelijk voor de lease met de klant
- De service provider moet omgaan met de verschillende specifieke omstandigheden van de bouwindustrie
- De service provider is verantwoordelijk voor het kiezen van de benodigde producten en services
- De service provider moet de levensduur van het gebouw bepalen
- De service provider moet verifiëren of de ontkoppelpunten daadwerkelijk aanwezig zijn

De businessmodelprototypen

Nu het duidelijk is op welk type service provider en op welke activiteiten dit onderzoek zich richt, is het nu tijd om te onderzoeken op welke manier de service provider deze activiteiten moet uitvoeren. Daartoe worden gebruik gemaakt van het businessmodelraamwerk van Bocken en Short (2015). Dit raamwerk is opgebouwd uit drie verschillende ‘bouwstenen’; waardepropositie, waardecreatie en -levering en waardevangst. Bij geen enkele van deze bouwstenen zal dit onderzoek expliciet ingaan op de financiële omstandigheden, de redenen daarvoor zijn te vinden in de hoofdtekst van dit onderzoek.

Nu ook het raamwerk is het tijd om alle puzzelstukken op de juiste plaats te leggen. Daarvoor wordt hieronder een beschrijving gegeven van het generieke business model in het raamwerk van Bocken en Short (2015) (figuur DS2). Het grootste gedeelte van dit raamwerk dekt alle verschillende varianten, er zijn echter bepaalde onderdelen (7, 9 en 10) waar het prototype is onder te verdelen in
Value Proposition

1. Product / service
   Housing that is completely tailored to the needs of the customer, at a certain performance, for a given time-period

2. Customer segments and relationships
   Broad segment with specific clients looking for a specific performance

3. Value for customer, society, and environment
   The customer receives tailored housing, society and the environment receive this in a sustainable manner

Value creation & delivery

4. Activities
   The service provider performs one, some, or all of the following: designing, building, financing, maintaining, operating

5. Resources
   The inherent knowledge the service provider has about the activities it performs

6. Distribution channels
   Can differ between service providers

7. Partners and suppliers

8. Technology and product features
   Non-toxic, pure materials of which the origins are known, supported by renewable energy. Also flexible, but the amount thereof is dependent upon the chosen model under point 7.

Value Capture

9. Cost structure and revenue streams

10. Value capture for key actors (incl. environment and society)

11. Growth strategy / ethos
   Can differ between service providers

Figuur DS2: De vijf verschillende businessmodelprototypen met zowel de gezamenlijke als verschillende aspecten in het duurzame businessmodelraamwerk (eigen figuur, raamwerk door Bocken & Short (2015))

*Financing moet in dit model altijd gecombineerd worden met één van de andere activiteiten, het kan niet de enige competentie van de service provider zijn.
verschillende varianten. Deze varianten vinden hun oorsprong in het onderzoek zoals dat tot op dit punt is uitgevoerd en zorgen er voor dat de service provider kan omgaan met de specifieke omstandigheden van de bouwindustrie. Om dit mogelijk te maken zijn de verschillende varianten opgebouwd uit de volgende variabelen;

- De eerste variabele kijkt naar de competenties die aanwezig zijn in de organisatie van de service provider.
- De tweede variabele kijkt naar een mogelijke rek van de organisatie van de service provider.
- De derde variabele kijkt naar de verhoudingen tussen de service provider en zijn leveranciers.

Wanneer de businessmodelprototypen worden vergeleken met de literatuurstudie vallen er een paar punten op. Ten eerste liggen de varianten 1, 2 en 3 het dichtstbij de circulaire economie zoals deze in dit onderzoek is geïntroduceerd, de varianten 4 en 5 komen voort uit het bestuderen van andere industrieën. Alle vijf de varianten zijn echter gevorderde servicemodellen. Ten tweede is het belangrijk om in het achterhoofd te houden dat, ondanks dat door middel van onder andere ESCO-achtige constructies, financiële obstakels zoals deze werden gevonden in de inleiding nog steeds plaats zouden kunnen vinden. Dit omdat het ontbreken van concrete cases het onmogelijk maakt om dit op voorhand uit te sluiten. Ten derde kan, vanuit praktisch oogpunt, worden betwijfeld in welke mate de ontwikkelde varianten waarschijnlijk zijn in de huidige bouwindustrie.

**De service provider in de praktijk**

Om de praktische relevantie van de ontwikkelde businessmodelprototypen te testen zijn deze onderwerp geweest van verscheidene validatie-interviews. Hiervoor zijn vier verschillende partijen benaderd vanuit verschillende invalshoeken van de bouwindustrie. Dit is gedaan om een breder beeld van de aanbodzijde te krijgen, alle geïnterviewde partijen zijn Nederlands. Eén partij houdt zich bezig met het onderhoud van woningen voor woningcorporaties, een andere partij is een middelgrote aannemer, de derde partij is een grote aannemer en de vierde partij is een grote aannemer en ontwikkelaar. Van deze vier partijen heeft de grote aannemer en ontwikkelaar daadwerkelijk ervaring met een basis tot gemiddeld circulair service project. De grote aannemer heeft zich de laatste tijd beziggehouden met het implementeren van de circulaire economie in de afvalstroom van het bedrijf. Zowel de middelgrote aannemer als het onderhoudsbedrijf hebben geen ervaring met het opleveren van circulaire projecten. Het is echter wel belangrijk om te beseffen dat elke geïnterviewde partij zich recent heeft beziggehouden met ofwel een circulair ofwel een anderzijds duurzaam project. Op de vraag of de geïnterviewde partijen de circulaire economie als een kans zien voor hun bedrijf werd gesteld dat dit of al zo is of dat het in de lijn der verwachting ligt. Volgend op de interviews zijn enkele casestudies uitgevoerd die betrekking hebben op enkele duurzame projecten waarmee de respondenten zich recent mee bezig hebben gehouden. Het doel van deze casestudies was om te kijken in welke mate deze projecten zich verhouden tot de circulaire economie zoals deze is geïntroduceerd in dit onderzoek.

**De mate van toepasbaarheid van de businessmodelprototypen**

Over het algemeen kan worden gesteld dat de respondenten de analyse zoals deze uiteen is gezet in dit onderzoek onderschrijven. Deze analyse resulteerde in een lijst met randvoorwaarden en bedrijfsprocessen voor de service provider, aan de hand van de interviews kan deze echter licht worden aangepast (voor de aanpassingen wordt verwezen naar de roadmap (zie paragraaf 7.5)). Tegelijkertijd kan worden opgemerkt dat de businessmodelprototypen niet direct toepasbaar zijn in de bouwindustrie. Voor de respondenten lag een basis- tot gemiddeld service model meer binnen de verwachting. Op de langere termijn werden de prototypen echter wel mogelijk geacht.

Daarin werden sommige varianten als waarschijnlijker beoordeeld dan anderen, zo werd de implementatie van variant 1 bijvoorbeeld niet als waarschijnlijk gezien. Hoewel uit de literatuurstudie juist bleek dat dit de variant is die het dichtst bij de circulaire economie theorie staat. Naast variant 1 werd ook variant 4 niet als waarschijnlijk gezien door de geïnterviewden. En hoewel variant 2 door één respondent wel mogelijk werd geacht (met additionele randvoorwaarden), bleek dat zowel variant 3 als 5 als het meest waarschijnlijk werden gezien (figuur DS2). Een
eventuele verklaring hiervoor zou gevonden kunnen worden in het feit dat deze twee varianten het meest overeenkomen met de huidige bouwindustrie, vooral wanneer deze worden uitgevoerd in een consortiumvorm. Op die manier laten variant 3 en 5 een gelijkenissen zien met publiek-private partnerschappen zoals deze steeds meer voorkomen in de bouwindustrie. Tegelijkertijd met deze constatering moet worden opgemerkt dat één van de casestudies opmerkelijke gelijkenissen vertoonde met een variant 5 oplossing, het zou dus kunnen zijn dat implementatie van de prototypen dichterbij is dan de respondenten voor mogelijk houden.

Wie neemt de rol van de service provider op zich?
De vraag welke partij de rol van de service provider op zich neemt wordt niet helemaal beantwoord. Zou dit bijvoorbeeld één van de bestaande partijen in de bouw moeten zijn of kan het zo zijn dat een externe partij deze rol op zich gaat nemen? Er kunnen wat dat betreft wel enkele opmerkingen worden gemaakt over wie deze rol zou moeten vertolken evenals enkele gevolgen voor andere stakeholders in het proces (zie de gevolgenkaart in paragraaf 7.5). Zo lijkt het er bijvoorbeeld op dat wanneer de service provider vanuit de bouwindustrie zelf komt, dat deze rol waarschijnlijk wordt ingevald door een consortium van verschillende partijen. In dit consortium zouden partijen die nu een coördinerende rol hebben in het bouwproces naar alle waarschijnlijkheid het meest geschikt zijn om een leidende rol op zich te nemen. Deze organisatievorm zal er echter wel toe leiden dat deze leidende partijen sterk afhankelijk zijn van andere leveranciers om genoeg competenties binnen het project te verkrijgen om deze met succes af te kunnen ronden. Dit zou het moeilijker kunnen maken om de afgesproken prestatie ook daadwerkelijk te kunnen leveren. Aanwijzingen vanuit de casestudies wijzen erop dat een consortium niet per sé nodig hoeft te zijn voor een efficiënte levering van de prestatie, al zullen projecten die zonder consortium worden uitgevoerd welk kleiner van grootte zijn. Wanneer de service provider een partij uit een andere industrie zou zijn, kan worden betwijfeld of de varianten 3 en 5 ook voor deze acteur het meest voor de hand liggen. Welke varianten dat dan wel zijn is niet geheel duidelijk. Wat wel duidelijk wordt is dat wanneer deze externe partij minder afhankelijk zou zijn derden, dit een voordeel op zou leveren vanuit circulair oogpunt.

Ondanks dat de prototypen als mogelijk werden gezien, kwamen er uit de interviews ook wat obstakels naar voren die deze mogelijkheden zouden kunnen verminderen. De twee grootste uitdagingen die werden gevonden zijn financiële en juridische obstakels. Het financiële obstakel werd al eerder geïdentificeerd als het op één na grootste obstakel (na het organisatorische obstakel). Vanuit de interviews komt naar voren dat met name de toekomstige financiële waarde van producten als een onzekerheid wordt gezien. Onderzoeksresultaten van Stigter (2016) laten zien dat de financiële winstgevendheid van leaseconstructies in de toekomst met name afhankt van stijgende grondstofprijzen. Stigter (2016) erkent daarbij ook dat de circulaire economie niet per sé duurzaam hoeft te zijn wanneer deze grondstofprijzen niet stijgen, omdat in dat geval de financiële prikkel voor deel nemende partijen ontbreekt. Het juridische obstakel heeft met name te maken met de volgende twee aspecten; ten eerste is het onder huidige wetgeving lastig om verschillende regels en eigenaren te hebben voor verschillende onderdelen van een gebouw. Dit omdat de huidige regelgeving uitgaat van een gebouw als één geheel. Ten tweede zorgt progressieve regelgeving omtrent bouwwezen er voor dat het moeilijk is om te bepalen of een product dat nu kan worden ingezet, ook na een bepaalde periode in een andere kringloop weer opnieuw kan worden ingezet. Ten opzichte van dit tweede obstakel zijn enkele nuances aan te brengen, deze zijn opgenomen in de roadmap (zie paragraaf 7.5).

Naast de twee bovenstaande obstakels worden de businessmodellprototypen momenteel ook gehinderd door de marktvraag. Het is namelijk nog onduidelijk in welke mate er een marktvraag gaat ontstaan voor gevorderde circulaire services. Omdat uit het circulair service niveau raamwerk blijkt dat er meerdere manieren zijn om duurzaamheid te borgen binnen de circulaire economie, is duurzaamheid alleen niet genoeg reden om voor gevorderde circulaire oplossingen te kiezen. Wanneer wordt gekeken naar cases uit andere industrieën wordt duidelijk dat de belangrijkste reden om voor gevorderde
oplossingen te kiezen het verleggen van risico is. Als dit gegeven wordt vertaald naar de bouwindustrie, zal dit betekenen dat de marktvraag voor gevorderde services zich met name zal manifesteren bij partijen waar het hebben van de juiste faciliteiten dermate belangrijk is dat zij het risico zullen willen verleggen naar een externe partij.

Zoals verwacht blijkt uit de resultaten dat ook innovatie op verschillende vlakken binnen de bouwindustrie moet plaatsvinden om het effectief uitvoeren van de businessmodelprototypen mogelijk te maken.

Een roadmap en de gevolgen voor stakeholders binnen het bouwproces

Om de activiteiten van de service provider die nodig zijn om zijn rol goed te kunnen vervullen is op basis van de onderzoekresultaten een roadmap opgezet. Deze roadmap is te vinden in paragraaf 7.5 van dit onderzoek. Daarnaast zijn de gevolgen van het leveren van gevorderde circulaire services op verschillende stakeholders in het bouwproces in kaart gebracht voor de varianten 1, 3 en 5 (ook paragraaf 7.5). Hieruit komt voornamelijk naar voren dat er een hoop veranderingen plaats zouden kunnen vinden wanneer bouwprojecten op deze manier gerealiseerd zouden worden. Zo zouden verscheidene rollen zoals we deze nu kennen verdwijnen of een andere vorm kunnen aannemen.

Conclusies en aanbevelingen

Vanuit dit onderzoek kwamen vijf verschillende businessmodelprototypen naar voren gebaseerd op de aanwezige kennis van stakeholder over hun eigen competenties in het bouwproces. Deze businessmodelprototypen zijn ontwikkeld vanuit een uitgebreid literatuuronderzoek en zijn volledig gericht op gevorderde circulaire services. Dit werd gedaan om twee redenen: ten eerste is dit type oplossing nog niet aanwezig in de bouwindustrie. Ten tweede kan er aanzienlijke milieuwinst worden verwacht van dit type oplossing. Met het ontwikkelen van de prototypen is het eerste deel van de onderzoeksvraag te beantwoorden (hoe verhoudt deze organisatie zich tot de huidige stakeholders in het bouwproces?). Hierbij werd onder andere geconstateerd dat de businessmodelprototypen nog niet direct inzetbaar zijn in de bouwindustrie. Op de langere termijn werd implementatie echter mogelijk geacht. Alhoewel vanuit de casestudies bleek dat implementatie van de prototypen wellicht dichterbij is dan door de respondenten wordt aangenomen. Desondanks kwamen er enkele overtuigende redenen naar voren waarom de prototypen nog niet inzetbaar zijn:

1. Om de prototypen te laten werken is op meerdere vlakken in het bouwproces innovatie nodig.
2. Er kan sprake zijn van een financieel obstakel bij de implementatie van de prototypen. Onderzoek van Stigter (2016) maakt echter duidelijk waaruit dit obstakel precies bestaat.
3. Er is sprake van juridische onzekerheid omtrent de scheidbaarheid en her-inzetbaarheid van producten die worden gebruikt in het bouwproces (de roadmap laat zien waar op gelet moet worden).

Het is door een gebrek aan praktische implementatie nog niet geheel duidelijk welke partij de rol van de service provider op zich kan of gaat nemen. Ten eerste lijkt het aan de persoonlijke voorkeuren van de aanbiedende partijen te liggen of zij zich opstellen als een service provider of niet. Daarbij kan worden opgemerkt dat partijen als aannemers of ontwikkelaars (die een coördinerende rol spelen in het huidige proces) dichter bij deze rol zouden kunnen zitten in sommige varianten. Vanuit de kaart met gevolgen voor de stakeholders in het bouwproces wordt duidelijk dat de keuze om met of zonder consortium gevorderde services te leveren, aanzienlijke gevolgen kan hebben voor de huidige stakeholders in het bouwproces. Ook kan de eventuele toetreding van een externe partij verstrekende gevolgen hebben op de bouwindustrie.

Gegeven het feit dat de businessmodelprototypen naar alle waarschijnlijkheid niet in de nabije toekomst geïmplementeerd worden, kan worden geconcludeerd dat de circulaire economie (ten minste in de nabije toekomst) in de bouw voornamelijk zal worden geleverd via basis- tot gemiddelde services. Voorbeelden hiervan kunnen nu al worden
gevonden in verscheidene casestudies binnen dit onderzoek. Deze constatering leidt er op zijn beurt toe dat de te behalen milieuwinst op korte termijn ten gevolge van de circulaire economie slechts marginaal zal zijn.

Op basis van dit onderzoek kunnen de volgende aanbevelingen voor verder onderzoek worden gedaan:

• Ten eerste wordt verder onderzoek omtrent de bevindingen van dit onderzoek aangemoedigd.
• Daarnaast zou verder onderzoek zich, om het meeste van de marginale milieuwinst te maken, moeten richten op het ontwikkelen van volledige businessmodellen voor basis- tot gemiddelde services.
• Er moet verder onderzoek worden gedaan naar de in dit onderzoek gevonden juridische obstakels.
• Er is ook verder onderzoek naar de mogelijkheden voor verticale integratie binnen organisaties in de bouw.
• Het vinden van een eventueel pilotproject wordt sterk aangemoedigd.

Op basis van dit onderzoek kunnen de volgende aanbevelingen voor marktpartijen worden gedaan:

• Marktpartijen worden aangemoedigd om, mits compleet geïnformeerd over gevorderde circulaire services, deze te ontwikkelen aan de hand van dit onderzoek.
• Wanneer marktpartijen daartoe besluiten kan er waarschijnlijk het best gestart worden met een project dat:
  1. Gericht is op het afleveren van een project op basis van een product
  2. Een geringe mate van stakeholders bevat
  3. Een nieuwbouwoplossing bevat
  4. De mogelijkheden van een bepaalde rigiditeit vs. flexibiliteit duidelijk maakt
  5. Zich niet direct richt op een variant 3 of 5 oplossing aan de hand van een consortium
• Aan de hand van de potentiële rol-wijzigingen in het bouwproces worden marktpartijen aangemoedigd om (1) kritisch te kijken naar de competenties die binnen de organisatie aanwezig zijn en (2) kritisch te kijken naar de uniciteit van de geproduceerde producten.
• Marktpartijen worden aangemoedigd om naast het opvolgen van gevorderde circulaire service oplossingen te kijken naar basis- tot gemiddelde oplossingen.
Reading guide
When taking a closer look at the circular economy it has become clear to me that little is known about the practical implications of it. There has been a lot of writing in recent years but a lot of it stops at an abstract level, making it hard to imagine an actual circular economy working in an every day situation. This report starts out with presenting the research setup, this includes the problem statement that followed from an analysis and elaborates upon the main problem that was found. After this part, there is a section that deals with the appropriate research question to ask in order to be able to solve the problem. Afterwards the research design as it is followed in this report is presented.

The second part of the report presents a comprehensive literature review complemented with several thought exercises. These reveal an underlying problem (the problem statement was derived from this analysis), through subsequent further literature and case studies from within and outside of the construction industry examples are found of how to deal with this research problem.

The third part of the report incorporates all of the lessons learned through the earlier chapters and bundles this gained knowledge in so-called business model prototypes. These prototypes give the supplying parties in the construction industry the tools to determine what needs to be done in order to be able to engage in circular business solutions. These models are then validated through interviews with practitioners, several case studies and other literature as to ensure their functioning.
Part I: Research methods
1. Research Organization

This chapter of the report will introduce and elaborate upon the research organization. It will show the motivation for doing this research, the problem statement, relevance of the research, the research question(s), the goal (or aim), and the research methods of this research. After this chapter it will therefore be clear what is researched, why it is researched, and how it is researched.

1.1 Motivation

Whilst thinking about a possible topic for a graduation project, I found myself continuously getting back on how to make real estate a more liquid asset as it were. These days practically every asset you could think of has experienced some kind of innovation that made it more liquid, flexible or just more accessible. Practically every asset that is, within the field of real estate practices have not changed that much since the beginning of modern days. There must surely be some way of accomplishing this goal, but it requires new approaches to traditional practices. That is why, when checking the graduation guide for last spring, my eye immediately fell on the implementation of the circular economy in real estate.

Circular economy theory provides a new, fresh outlook on many industries including the real estate and construction industry. Could this new outlook change real estate and the construction industry into a more liquid, flexible or accessible industry? In my opinion it just might and it is therefore that I think it is a topic worth exploring.

After doing extensive research and thought exercises, the main study target for this research is to find out how circular economy could be organized in the construction industry. As simple as this question might seem, it will become apparent through this report that there is no direct answer to be found in current literature or straightforward roadmaps that show how this can be done. Apart from this main goal, for me personally it is also about obtaining more detailed knowledge about the responsibilities of the different actors in the construction process, the economic value of the work they do and their business organization. In doing so essentially combining all of the knowledge and skills I acquired in earlier education into my master's thesis.

1.2 Specific problem / Problem statement

This section will describe the exact problem under investigation in this research. In order to do so, this section builds upon a problem analysis that can be found in the second part of this report (a complete version of this section is available as chapter four in this report). This analysis yielded definitions and obstacles for implementation of the circular economy in the construction industry. From these definitions and obstacles a central problem statement could be extracted, which will be explained below.

After a study of both the circular economy concept and the current construction industry, an attempt is made to combine the two in order to come to a circular construction economy. This process however yielded several impracticalities and obstacles. Further analysis reveals that these obstacles reside around an organizational problem. While investigating the organizational problem, it becomes clear that this problem is in fact a problem of scale (figure 1). This scale problem in turn causes a division of interests amongst the stakeholders in the building process. This division of interests combined with other findings on circular economy theory, make clear that this scale problem is not to be solved through the
‘traditional’ project organization depicted by figure one (the entire analysis can be found in chapter four).

Therefore it has become clear that in order to be able to implement the circular economy in the construction industry, a service provider at the building level is needed. Implementing a new entity within the project organization (albeit only for research purposes) would create a clear focal firm for the supply side of the construction industry, eliminating existing barriers towards collaboration between the supplying parties in the industry. The new entity therefore provides an opportunity to study what the supply side needs to offer in a (idealized) circular construction industry without being hindered by current conventions (see figure 2).

The general idea of a service provider is not new, in fact the Ellen MacArthur Foundation (2012) already implemented a service provider in their depiction of the concept (see figure 5). However the service provider as it is proposed here differs from the one that is proposed by the Ellen MacArthur Foundation (2012) in that the operations and all of the surrounding relationships of the service provider are the subject of investigation. This while the service provider as proposed by the Ellen MacArthur Foundation has a fixed position in the concept with fixed, unclear operations and relations, thereby surpassing deeper research into its role without properly understanding it.

Therefore this research offers, as explained above, a chance to design the role of the service provider without being hindered by current conventions (including the circular economy concept as it is laid out in figure 5). This service provider would need to form the basis for solving the problems that were stated in the problem analyses and incentivize the stakeholders in the right way following the definition of the circular economy that will be provided in the second part of this report. Therefore the main problem under investigation in this report is:

‘an organization of the service provider that adheres to the definition and principles of the circular economy, and how current supply side stakeholders relate to this actor’
The next section will pose the questions that will guide this research in the direction of the answer to the above stated problem.

1.3 Research question

This section will introduce the main research question that is posed in this research following the earlier section that introduced problem statement. After the introduction of the main research question there will also be an explanation on some detailed research questions.

The main research question

The main research question of this proposal follows the problem statement and is:

‘How to organize a service provider at the building level in such a way that its role adheres to the definition and principles of the circular economy?’

and secondary:

‘How does this service provider relate to the current supply- and demand side stakeholders in the construction process?’

The research question is a translation of the research problem and will essentially have to deal with the organizational setup of the service provider and two different transactions; one between the user and the service provider, and one between the service provider and the supplying parties. This research will focus on these particular transactions as circular economy will have the biggest organizational impact on the supply side of the construction organization. How to deal with this organization and these transactions will become clear through several detailed research questions that will be elaborated upon below. Through the secondary question it will become clear to what degree current parties can relate
themselves to the role of the service provider. And by that it will also be apparent to them how far they are currently off from being a circular actor, enhancing the practical relevance of this research.

Sub-questions
In order to be able to answer the main research question, several sub-questions need to be answered first. The sub-questions will therefore be explained in this section as well as the reason(s) for these questions to be asked.

1. What is circular economy and what does it attempt to accomplish?
   1. What makes up the concept of the circular economy?
   2. What does the circular economy try to realize?
   3. What is the definition of a circular economy (if there is one)?

This first question serves to get a view of the circular economy as a whole, this is important as there is as of yet no clear theory nor definition of the circular economy that is ready to be used in this research.

2. What does the construction industry look like?
   1. What are the characteristics of the construction industry?
   2. What is the role of the different stakeholders in the current construction process?

This question will come up with a description of the current construction process and the role of its stakeholders. It is important to come up with a general description of the construction industry in order to be able to make a link with the circular economy concept that was outlined under question one.

3. What will implementation of circular economy mean for the construction industry?
   1. In what way will the current characteristics of the construction industry be affected by the circular economy?
   2. To what extent is current circular economic theory useable in the construction industry?
   3. Where to find the incentive in the construction industry?

The third question ties the investigation that was done for the first two questions together. This question poses an investigation as to where to find the right incentive for the circular economy in the construction industry, and therefore comes up with a justification for the creation of the role of the service provider in the construction project organization (This question builds upon knowledge acquired through the first two questions and might therefore seem a bit ‘out of the blue’, however after obtaining the answers to the first two questions this question will appear logical).

4. How can the service provider be organized?
   1. What does the service provider need to do following circular economic theory?
   2. How does a service provider operate in other / different industries?
   3. How can the service provider be organized in a circular construction industry?

This question makes up the design of the organization of the service provider, it therefore uses input from the questions that were posed earlier and poses new questions in relation to the business model of the service provider. The sub-question 4.3 will be answered through the design of several business model prototypes, these business model prototypes
are modelled after the sustainable business-model framework that was developed by Bocken & Short (2015) (more information on this framework can be found in section 6.2).

5. How can the service provider be organized according to actors from current practices?
   1. What does the service provider need to do according to actors from current practices?
   2. How do the different stakeholders see their role related to that of the service provider?

This question serves to nudge the preliminary designed role of the service provider from the previous question in the right direction by inquiring actors from the supplying field about their view on the service provider. And also to position the current supplying stakeholders in relation to the role of the service provider.

6. Examining the service provider
   1. Does the designed business model adhere to the definition and principles of the circular economy?
   2. Is the designed business model consistent with all earlier findings in the research?
   3. How do the different stakeholders relate to the designed business model prototypes?
   4. Does the role of the service provider also have consequences for other roles in the organization of the construction project?

This final section serves to validate the service provider business model that was designed before by crosschecking it against the different aspects named in the sub-questions of section 6.

1.4 Final result
The main question to be answered should be: How to organize the service provider in such a way that its role adheres to the definition and principles of the circular economy, and secondary: how does this organization relate to the current supply side stakeholders in the construction process?

In order to answer this question, the sub-questions will yield answers about the positions/interests and business models of the supplying parties present in the construction process. The research should therefore yield a final result in the form of different business model prototypes. These provide insights and/or solutions as to how the service provider will deal with the ‘new’ context the circular economy provides for the supplying parties in the construction industry. Specifically the to be developed business model prototypes will deal with the main transactions surrounding the service provider; one between the user and the service provider, and one between the service provider and the supplying parties. In doing so, also the relation between the service provider and the current supply side stakeholders can be evaluated. Through this evaluation it becomes possible to see to what degree current parties can relate themselves to the role of the service provider. And through that it will also be apparent to these parties how far they are currently off from being a circular supplier, thereby enhancing the practical relevance of this research.

It is chosen to create different variants of business model prototypes as the lessons learned do not point towards one single way in which the service provider can organize its business. Each variant will be presented through the sustainable business model framework as presented by Bocken & Short (2015). This business model framework offers guidelines as to how to generate new business models and shows the relationship between different actors.
and resources. By using this framework it will become clear in what way the role of the service provider will function in the construction industry. In section 6.2 an explanation will be given as to why this framework is preferred over other alternatives.

Because of the way the different variants are set-up, they will besides presenting readers with clear business model prototypes, also be able to be used in a business plan (as laid out by for instance Osterwalder & Pigneur, 2010), while at the same time they could also be used as scenario’s to form the basis for scenario planning as laid out by Lindgren and Bandhold (2003).

1.5 Relevance
This section will explain the relevance of this research on different levels to show the added value of this particular research project. The relevance will be explained on three different levels; scientific, social, and practical.

Scientific relevance
Existing literature on the circular economy often gets stuck at an abstract level, making it hard to connect the circular economy to for instance people, companies, projects, processes, and business sectors (Antink, et al., 2014; De Grauw, 2015; Ellen MacArthur Foundation, 2014; Kok et al., 2013; Mentink, 2014; Van Dijk et al., 2014). In other words there is a literature gap on the practical implementation of the circular economy. When a look is given to the construction industry it becomes apparent that there is (through the aforementioned literature gap) also a literature gap in this particular industry. Although there has recently been an influx of research on the circular construction industry at the faculty of architecture and the built environment at Delft University of Technology in an attempt to close this gap, none of this research focuses on the circular service provider from a supply-side perspective. While De Grauw (2015) touches upon the circular service provider in his research, he does this from a demand perspective and thereby uses the circular economic concept more or less literally as it is laid out by the Ellen MacArthur Foundation (2012). This research is therefore unique in that (1) it investigates the circular construction service provider from a supply-side perspective, and (2) does this from a carefully built-up theoretical construct that critically reflects upon both existing circular economy theory and the current construction industry before coupling the construct back to practice. Therefore general aims of this research are to bridge the literature gaps by providing a practical model implementing the circular economy within the construction industry while on a higher abstraction level working out the circular economic concept as well.

Societal relevance
The effects that the circular economy might have on a societal scale are enormous. Bastein et al. (2013) estimate that in The Netherlands alone the circular economy has the potential to create 54.000 jobs and generate €7.3bn in annual savings. The accuracy of these figures can be contested, as its accuracy greatly depends on how one interprets the circular economy. Even so, if the aforementioned figures would hold true for only half their size the observable effects would be considerable. Apart from creating jobs and cutting costs, the circular economy also aims to design out waste through a different approach towards products. In this way, the circular economy shows the potential to make the world a more sustainable place.

Practical relevance
The results of this research are directed at the supplying parties in the construction industry, by providing business model prototypes for these parties. Each prototype will be presented
through the sustainable business model framework as presented by Bocken & Short (2015). This business model framework offers guidelines as to how to generate new business models and shows the relationship between different actors and resources. By using this framework it will become clear in what way the role of the service provider will function in the circular construction industry. These prototypes form tools that can be a part of future circular business plans (e.g. the prototypes fit in the lay-out of a business plan given by Osterwalder & Pigneur (2010)) or form different scenarios and therefore the basis for scenario planning as laid out by Lindgren & Bandhold (2003). In this way the results of this research will be applicable to all supplying parties in a circular construction industry, and will be the first (as far as the knowledge of the author is concerned) business model prototypes for a service provider in a circular construction industry from a supply-side perspective.

1.6 Research design and methodology
This section will give an overview of the research organization behind this research proposal. This section will therefore answer questions like what kinds of methods are to be used, how they are to be used and what kinds of results are to be expected of these methods. This research will focus on qualitative methods in a pragmatic approach in order to answer the research questions posed. This is mainly because of the nature of information needed in order to solve the stated problem. Below, figure three gives an overview of the entire research organization and helps to clarify the explanations below that will focus on what the different steps entail.

![Figure 3: Research organization of this proposal (Own image).](image)

General research method
What sets this research apart from most other researches is the fact that there is little or no earlier literature available that is useful for this particular research. This is also explained in chapter 2 of the second part of this report. There is, as of yet, therefore also no paradigm on which to built further research. These features indicate that pragmatic research methods are
the best solution for this research. Therefore inspiration will be drafted from the case study approach as proposed by Eisenhardt (1989).

If Eisenhardt’s method is offset against other (more conventional) research methods, it becomes clear that Eisenhardt (1989) provides more backbone for this particular research. The ways in which become clear when looking at the following points:

- There is as of yet no grounded theory and/or paradigm on the circular economy, the research method proposed by Eisenhardt (1989) provides tools as to how to deal with research where no grounded theory and/or paradigm is present. These tools are not provided by the likes of Bryman (2012) and Kumar (2011).
- Due to the lack of grounded theory and/or paradigm as described above, it is also as of yet not possible to ascertain in what way the circular economy will impact the processes and organization in the construction industry.
- The research method proposed by Eisenhardt (1989) makes use of several different qualitative methods (and possibly quantitative methods as well) in order to overcome the issue of information availability. This way an effort is made on multiple fronts in order to establish theory, it is as such a pragmatic research method.
- Lastly Eisenhardt’s (1989) research method comes from the field of management and is primarily concerned with organizational issues, which is also the topic under investigation in this research.

However, this research will not copy the research process as laid out by Eisenhardt (1989) one-on-one, since the final steps of the prescribed process deal with comparing findings with literature in order to validate them. This is not seen as an option in this particular research due to the absence of such literature. Therefore Eisenhardt’s (1989) method will be used in this research as a guideline as to how to deal with different data gathering methods (which will be explained in the next section) and as an example on how to treat the gathered data.

This research will therefore strike a resemblance to Eisenhardt’s (1989) prescribed research process, when it for instance, comes to combining different research method’s together in order to gather the necessary data. In other areas, like the strict build-up of chapters or drafting of conclusions, this research will not follow Eisenhardt (1989) that tightly. This as throughout this research, the focus will continuously be on linking those methods to the research questions in such a way that a satisfying answer can be found. In a way this research is thus more pragmatic than Eisenhardt’s (1989) method. On the other hand, this research does not make use of both qualitative and quantitative research methods, which is something that is frequently seen in pragmatic and/or mixed method research methods (Bryman, 2012). However, it was determined that use of quantitative research methods would not have yielded more satisfactory answers to the research questions of this research at this point in time.

At the heart of this research are two general themes; circular economy in general, and the to be developed business models (figure 4). This is the case as there is a need for building theory on both themes. It is important to also build theory on the circular economy in general, as this will provide the frame for the models that will be designed for the construction industry. In this way a double feedback loop will be created in this research, coupling the two different aspects together (see figure 4). As such, the research process will be (highly) iterative and will therefore continuously loop back and forward. Information
gathering in later stages of the research will therefore be more focused than at the start of the research (through higher data availability and the forming of theory).

![Diagram](image)

**Figure 4:** The double feedback-loop between the two different aspects of research (own image)

**Rules and guidelines for data collection methods**
This section will outline some rules and guidelines for the data collection methods to be used in this research, these rules and guidelines are based upon the reasons for and information requirements for these specific data collection methods as described by Eisenhardt (1989).

**Literature review**
Through a literature review it becomes clear what the state of knowledge is in a certain field of study. It is triggered by ‘what’-questions that attempt to establish a current state of knowledge as well as knowledge gaps. According to Kumar (2011) a literature study (1) entails four steps that need to be followed:

- Searching for literature in the area related to the research
- Reviewing existing literature
- Developing the theoretical framework
- Developing the conceptual framework

This research is no different in that for both building the theory on the circular economy, and the implementation in the construction industry the literature study follows this pattern. However for the implementation within the construction industry, the literature study (2) also follows a different way of operating. Since one of the goals with the literature study here is also to compare literature to the conceptual framework that was already created and to compare it against other fields. These changes yield the following steps:

- Searching for literature in areas that are different from the field of research (but do however show relevance)
- Reviewing existing literature
- Reviewing the underlying theoretical framework
- Reviewing the underlying conceptual framework

**Interviews**
The interviews to be held in this research will be of a semi-structured nature. This is due to the qualitative information requirements surrounding these interviews. Within this research, interviews form a way to consult actors from practice about their thoughts on the circular economy and implementation thereof in the construction industry. It is possible that these actors might have knowledge about these topics that is as of yet not apparent by the researcher (due to the literature gap surrounding the topic), rambling off is therefore
encouraged as this might reveal new information. According to Bryman (2012) this kind of interview is best suited for these information requirements.

The specific goals for the interviews differ from where they take place within this research, and therefore the interviewees might differ as well (see table 1, and figure 3). Interviews about the general theory of the circular economy (type 1) are aimed at general theory, and interviewees might therefore include actors that are not closely linked to the construction industry (but preferably are, as interview types 1 and 2 might then be combined). Interviews about the implementation within the construction industry (type 2) are aimed at practical implementation, and interviewees should therefore have a close relation to either the construction industry or an industry with similar characteristics. Finally interviews might be used in order to validate findings from this research (type 3), these interviews follow the same guidelines as those about the implementation in the construction industry.

In this research, one type 1+2 and one type 2 interview were held. For these interviews the convenience sample approach was adopted. One of the respondents is active in the construction industry, one is active in another industry. Furthermore four type-3 interviews were held for this research. Also for these interviews the convenience sample approach was adopted. All four respondents to the type-3 interviews are active in the construction industry.

All type (1&)2 interviewees were interviewed on a single occasion, for approximately 45 to 60 minutes. One interview was done in person and one interview was done through e-mail. At the start of the interviews, interviewees were asked if they gave permission in the recording of the interviews. After the interviews were done, the recordings were transcribed into computer files and shared with the interviewees for a final check. Care was taken to assure the interviews of the respondents are not identifiable in either this or subsequent reports if they did not provide permission to enable this (also see limited accessibility of data).

All type 3 interviewees were interviewed on a single occasion, for approximately 45 to 75 minutes. Three interviews were done in person and one interview was done via telephone. At the start of the interviews, interviewees were asked if they gave permission in the recording of the interviews. After the interviews were done, the recordings were transcribed into computer files and shared with the interviewees for a final check. Care was taken to assure the interviews of the respondents are not identifiable in either this or subsequent reports if they did not provide permission to enable this (also see limited accessibility of data).

The interviews were recorded, transcribed, and subsequently coded. The coding process as laid out by Dierckx de Casterlé et al. (2012) has been followed to analyse the gathered data. For the data analysis the software package Atlas.TI has been used.

Thought experiments / exercises

Thought experiments or exercises form a way to check the conceptual models that are being developed through this research against the current situation and/or literature. For this comparison it is important that the current situation is described accurately in order to enhance the meaning and effect of these exercises. This means that the existing situation should be supported through literature, interviews, and/or case studies as much as possible. As such it makes it possible to check the usefulness of a conceptual model and its coherence with existing situations. In other words it helps to keep check with reality, and guide the
research towards the aims it has set. In this way the thought experiments and/or exercises take on a role similar to the ‘field notes’ as described by Eisenhardt (1989).

Case studies
It was described earlier that, following the description of Eisenhardt (1989), a case study can be seen as more of a collection of different specific techniques combined. For instance; interviews, own interpretations, field notes, and even statistical data may all be combined to describe a case as long as it adheres to the greater goal of the case study; building theory. Therefore, the earlier described data collection methods will sometimes be part of (and form) a case study. The earlier mentioned guidelines remain the same whether the data collection method is part of a case study or not.

Limited accessibility of data
All but one interviewee requested the interview to be confidential. As such those interview-results are incorporated anonymously in this report. The transcriptions of those interviews are however available for the tutors of this graduation project, albeit only to check their validity. Use of that raw data is restricted to this report only.

Research questions and the methods to be used per question
This section will explain the connection between the research questions that are posed in this research and the data collection methods that were described above (also see section 1.3). In order to make this clear, table one was constructed. Table one shows what research questions are answered through which collection method(s).

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Table 1: An overview of data collection methods that could be used for different research questions (own image).
Part II:

Literature review
2. Definition of the Circular Economy

*This chapter is co-authored by R. Stigter (contact details can be found in appendix A)*

This report will establish a definition of the circular economy that is useable in future circular construction industry research. This is important because as of this moment there is not one single, clear definition of the circular economy being used in literature. The first part of this report will start with an attempt to define the concept of circular economy following existing literature, to give readers a working definition of what it is circular economy attempts to do. The next section will deal with the exact definition of circular economy, and why it is difficult to state a generally accepted definition.

2.1 The circular economy concept

This section will give a general introduction of the circular economy concept as it is presented through literature. It will also provide some background as to why circular economy thinking exists and what sets it apart from other schools of thought. At the end of this section the reader will have a basic understanding of the circular economy concept.

**The need for a circular economy**

Since the beginning of the Industrial Revolution 200 years ago our economy has been characterized with consuming. Nowadays products are even designed in a way that they do not live up to our expectations after a few years. This is because in the current economy companies benefit from a short lasting product. Planing (2014) and Stahel (2012) describe this as a misaligned profit-share along the supply chain, causing an imperfect product design. The circular economy concept stems from the believe that linear consumption will reach its limits in the foreseeable future, and builds upon different earlier concepts like for instance cradle-to-cradle theory (Ellen MacArthur Foundation, 2014; Van Dijk et al., 2014).

The thought that linear consumption is reaching its limits originates for instance from the fact that the amount of resources that are available for use will decline steadily over the next years and decades. This leaves little to play with for future use, especially since the rate of recycling is low for most resources (Ellen MacArthur Foundation, 2014; Mentink, 2014). Other research concludes that over 99% of the material flow generated in order to produce goods, ends up as waste and is disposed after 6 months (Hawken et al., 2013). It can be questioned if these figures are exact, however it describes the urgency of a fundamental change of our economy. The reason that the rate of recycling is low under a linear consumption pattern is that there in general is no premium or gain on re-using materials, this leads to the take-make-dispose model that is used by most manufacturers nowadays (Ellen MacArthur Foundation, 2012). Take-make-dispose refers to the process where resources are taken from the environment, consequently used as part of making a product, and where that product is afterwards disposed back into the environment as it has no further use. This is occurring while the global middle class will more than double in size to nearly 5 billion people in the next 15 years, which will result in an increase in consumption and material intensity (Ellen MacArthur Foundation, 2012). By 2050, the population will grow to over 9 billion people, most of them enjoying increasing wealth (Godfray et al., 2010). This will lead to an economy demanding three times the amount of resources we currently use (Planing, 2014).

**The circular economy concept**

The Ellen MacArthur Foundation is the main promoter of the circular economy, which tries to design waste out of production processes by changing the linear consumption pattern to one where consumption is based on circular movements, thereby replacing the end of life
concept with restoration (see figure 5) (Bakker et al., 2014; Ellen MacArthur Foundation, 2014; Preston, 2012). So why has the circular economy concept increased in popularity the previous years, with amongst others the Ellen MacArthur Foundation actively promoting it? According to Planing (2014), three major changes led to this development. The first change has to do with increasingly volatile commodity prices. Raw material prices are on a constant rise and become increasingly volatile, which makes it more interesting to recover these materials after a product’s life ends (Bakker et al., 2014). The second change is the technical capacity of information systems, technology enables new business models, which were not feasible before. Thirdly, there is a shift in consumer behavior that leads to a performance over an ownership mentality.

The basic organization of the circular economy can be seen below in figure five. What is important to note are the two main cycles, the technical life cycle of the product and its resources on the right in blue, and the biological life cycle on the left in green. Circular economy attempts to create value by letting products ‘ride the cycle’, or in other words by adapting products when they no longer deliver the requested performance, instead of disposing of them. An important driver behind this thinking is that this would be a cheaper alternative over starting with fresh, new products as future commodity prices would be a lot higher given their finiteness (Ellen MacArthur Foundation, 2014). The cycles in figure 5 give examples of the routes that can be taken after the product’s lifespan has ended, what is important to add with respect to these routes is that the ‘shorter’ routes are preferred over the longer ones. When looking at figure 5, maintenance would be for instance preferred over the ‘refurbish/remanufacture’ cycle. This because the extra costs associated with shorter cycles are lower than those associated with longer cycles (Ellen MacArthur Foundation, 2014).

![Figure 5: Depiction of the circular economy concept. With on the right side the technical cycle (blue) and on the left side the biological cycle (green). Source: Ellen MacArthur Foundation, 2012.](image-url)
The difference between circular economy and other systems’ thinking

All of the above explanations about the circular economy concept could sound familiar as they demonstrate a close resemblance to the cradle-to-cradle concept. When it comes to objectives for re-use, both at a technical and biological level, the use of energy, and closing ‘business-loops’ in order to prevent waste, these are essentially transferrable between the two concepts (Van Dijk et al., 2014). Also the environmental issues in the previous paragraphs do not describe anything new. In the past decennia different parties discussed resource depletion and tried to design new models to step away from the linear model. Amongst those parties there is a wide acceptance that the current linear model is obsolete and should be replaced by a new, more sustainable model. This is also where the Circular Economy concept comes from, it is not Ellen MacArthur who invented the concept ‘Circular Economy’. The term itself has been used decades ago. In fact, it is a combination of a lot of different sustainable models from previous decades.

Stahel has been an expert on alternative models for more than 40 years. The Swiss architect performed several researches on the limits to our growth, and together with Giarini he emphasizes the need to change our consuming behavior (Stahel & Giarini, 1993). He was also the first person to introduce the Cradle-to-Cradle model, which is an approach for designing products, processes and systems that takes the whole product life cycle into account. The purpose is to restore continuous cycles of biologic- and technical nutrients, with long-term positive effects on profitability, environment and human health (McDonough & Braungart, 2002). Another model, biomimicry, is inspired by nature where all used materials can provide nutrition for further use without compromising the existent. Reap, Baumeister and Bras (2005), for example, described the potential of biomimicry as a sustainable design tool. This is just a small sample of many more sustainable models, such as; life cycle analysis, the performance economy (Stahel, 2010), industrial ecology (Ayres et al., 1996), blue economy, and regenerative design (Bakker et al., 2014; Lyle, 1996).

So what sets circular economy thinking apart from the aforementioned schools of thought? Circular economy is different in the way that it proposes a concept from the thought of economics, whereby sustainability can be seen as the major catch alongside a change in systems, whereas the cradle-to-cradle philosophy and other schools of thought focus more on the ‘loops’ and re-use themselves.

The above notion comes best to the fore in what the circular economy tries to do when it comes to incentivizing different actors in the process. In the circular economy theory it is in the producer’s own interest to follow the cycles as he stands to gain most from it, this is because in circular economy theory the producer often does not sell his or her product but leases it to the customer (Bakker et al., 2014; Ellen MacArthur Foundation, 2014; Roos, 2014). At the end of the product life cycle the product therefore is returned to the manufacturer. When the product that the manufacturer returns is filled with toxic materials, is unable to be disassembled in an easy way or uses low-quality materials, it is the manufacturer that is confronted with the costs to properly dispose of the product. This is the key-difference between other sustainable schools of thought and the current linear consumption pattern. By shifting responsibilities, actors will face costs for not using the correct methods or products that enable ‘cycle-riding’, thereby internalizing costs that could previously be considered as external.

2.2 Current state of literature

This section will deal with the validity of the current theory as it was presented in the earlier section; the circular economy concept. This will be done as it has become apparent when
reading further literature that the theory as proposed by the Ellen MacArthur Foundation shows some inconsistencies. It is important to note that this section does not serve as a rejection of circular economy thinking but more as an indication of the current state of literature, and therefore the need to come up with an industry-specific definition.

The definition of circular economy

The explanation that was given of the concept of circular economy earlier on in this analysis serves as an example to acquaint someone with the circular school of thought. However, when a closer look is given to the exact definition of a circular economy, it appears that there is some debate in literature (Mentink, 2014). According to Kok, Wurpel, and Ten Wolde (2013), Mentink (2014) and De Grauw (2015) there is no clear definition, since the transition to a circular economy will be a non-linear process, in which many aspects are uncertain. According to Mentink (2014) the Ellen MacArthur Foundation describes the concept as:

“an industrial economy that is restorative by intention”

Mentink (2014) furthermore notices that the reports of the Ellen MacArthur on the circular economy lack a definition that is well thought-out. Based on this definition of the Ellen MacArthur Foundation and supported by other literature on the subject, Mentink (2014) himself comes up with the following definition:

“a circular economy is an economic system with closed material loops”

The above examples indicate that there is as of yet not one clear definition of what the circular economy is and what it is not, also every author that writes in relation to the circular economy concept seems to have their own ideas about the definition of the concept. This seems to hollow the concept of circular economy towards a popular term or so-called ‘empty barrel’, a notion that is affirmed by Mentink (2014). What also becomes apparent is that circular economy thinking does not talk about sustainability and is ultimately, as stated earlier in this analysis, not about sustainability (Mentink 2014; Stahel, 2012). It is merely an effect of manufacturers working in a circular economic model.

Loppie’s (2015) designed his definition after reviewing the literature (EMF, 2012; Kok et al., 2013) and interviews with experts with the following result:

“An economical and industrial system, ecologic and economical regenerative by design, maximizing value retention and minimizing value destruction, aiming to retain the quality of life as much as possible.”

Again, a slightly different definition emerged, but also some overlaps can be mentioned. Quite logical, all three definitions speak about an economic system in which regeneration and ‘closed loops’ are key principles.

The circular economy concept itself

Following from the previous paragraph, the problem lies not only with a contested definition, this is illustrated through the following examples:

1) In an attempt to come up with an overview of what is circular economy and what it is not, Mentink (2014) tried to order the different aspects of circular economy thinking in a single schedule (figure 6). By examining this figure it becomes immediately apparent that
Figure 6: Hierarchy of different concepts in circular economy thinking (source: Mentink, 2014)
implementation of the circular economy in a business chain brings more complexity than the model provided by the Ellen MacArthur Foundation (2014) shows. It also shows that there is a sort of hierarchy in thinking about the circular economy and that some factors might be considered more important or at a higher level than others. What also comes to show is that the circular principles provided by the Ellen MacArthur Foundation (depicted in figure 6 in red) seem to appear at ‘random’ places in the hierarchy and to be of a different importance in implementing circular economy thinking, something that is not (directly) acknowledged by looking at the model the Ellen MacArthur foundation provided.

2) According to the Ellen MacArthur foundation (2012) an important characteristic is life extension. It could be questioned if this has anything to do with closing the material loops. The product should be designed in a way that it can be returned in the loops, minimizing waste and maximizing value. What happens after the products’ life should be of more importance than extending the functional use of a product.

3) Circular economy theory is about closing the loops. Materials should be reused as much as possible before they are renovated and recycled, but how bad is recycling/downgrading? An example comes from the construction of roads. A great part of the waste of concrete components in demolished buildings is used for the construction of new roads. In fact, these roads consist for a great deal of this waste. According to circular economic theory the concrete components should be reused first, which means the road construction can not use the concrete waste. In this way, new alternatives to build the road have to found. It could be argued if the latter is more sustainable.

4) A 100% circular economy does not exist; new raw materials are always needed (Mentink, 2014). Therefore there should be a difference between the ideal circular economy, which bans out all waste and uses only renewable energy and one that is practically achievable as the latter one is not. This is due to several reasons as pointed out by Mentink (2014):

  • Either there would have to be zero losses of technical material, or all materials would have to be biodegradable
  • Fully closed material loops imply zero material inputs (implying an ever continuing status-quo)
  • Closed material loops imply endless loops, but certain materials can only be re-used for a certain amount of times
  • Endless loops would also require endless amounts of energy

The above reasons show why a full circular economy is not achievable, and why there needs to be a difference between an ideal circular economy and a practical circular economy. The practical circular economy should however aim for the ‘highest’ possible affinity with the ideal circular economy.

5) The full implementation of the theory in practice will lead to great complexity in the loops. For instance, the production process of steel involves several steps, from mining the raw materials to the application of coating on the steel beam. According to the theory suppliers will retain the products in order to reuse it. But there are numerous steps between the mining of resources and the actual product. The theory is not clear about how far back the loops and their ownership should be taken.
2.3 The definition of a circular economy

This section will introduce a definition of the circular economy that is useful in further research. This definition is based on the review of the circular economy concept and its shortcomings, which were both elaborated in previous paragraphs. To make this definition more than another empty barrel, also some preconditions and context are given in order to ground the definition.

The definition of a circular economy

Following the previous paragraphs in this chapter it has become apparent that due to the vague boundaries surrounding the circular economy concept, the definition of the concept should be kept at a relatively high abstraction level. Therefore it is the authors’ belief that an adapted definition of Mentink (2014) provides the best definition of the circular economy concept:

“a circular economy is an economic system with cyclical material loops based on a financial incentive.”

Wherein ‘economic system’ refers to a combination of more than one interrelated parts or components that show how people deal with scarcity, ‘cyclical material loops’ refers to a loop that makes it possible for materials to keep cycling in these loops, and where ‘a financial incentive’ refers to a prospect on financial merits.

This definition does not contain anything related to the terms sustainability or value creation as the review in previous paragraphs has shown that these are side effects of a functioning circular economy. Also this definition contains the words ‘financial incentive’, as circular economic theory ascertains that this is the main reason for participating and therefore an indispensable part of circular economic thinking. This is not covered by the ‘economic system’ part of the definition as economics addresses the concept of utility of which a financial incentive could be a part, but this does not necessarily need to be the case.

Context and preconditions concerning the definition of a circular economy

Considering the shortcomings that were established in the previous paragraph, this section will ground the definition of a circular economy in order to make it more than an empty barrel.

1. A circular economy can (for reasons stated before) never be fully circular (which is the reason in the definition itself, the term closed loops is replaced by cyclical loops). A circular economy should however aim to come as close to a 100% circular economy as possible.
2. Life extension is not considered another loop as the product stays the same, no further alterations are required for this action. This has therefore nothing to do with circular design.
3. Downgrading through/or recycling is not a problem when it prevents using new resources.
4. In industries where there are several steps that need to be taken from mining a resource towards making it a product it should be examined at industry level which party should retain ownership of the needed resources.
Concluding Remarks
The first section of this chapter introduced the circular economy concept and indicated that it will impose a shift from linear consumption to circular consumption. In doing so, the circular economy will make it more attractive for manufacturers to make sustainable, durable products that are able to ‘ride the life cycles’. Put more strongly it is in the manufacturer’s own best interest to produce these products this way as in the circular economy model, he or she will remain responsible for the product instead of the consumer. This section also explained the difference between circular economy thinking and the cradle-to-cradle school of thought, this is mainly based upon the incentive thinking behind the circular economy that was explained above, whereby a more sustainable and durable world in circular economy is more of a consequence of the incentive shift as opposed to the goal through the entire process as proposed by cradle-to-cradle thinking.

The second part of this chapter showed that the circular economy theory as provided by the Ellen MacArthur Foundation should not be accepted without criticism; due to the current state of literature and theory it is for instance as of yet not possible to give one generally used definition of circular economy. Also circular economy thinking is principally not about sustainability, sustainability is a consequence of implementing the circular economy. Furthermore, current literature describes the circular economy at different levels without acknowledging these levels, also life extension (one of the loops in the Ellen MacArthur Foundation model) does not close a loop, it merely prolongs one. It can also be discussed if downgrading of materials does not fit the circular economic model as it does entail closing a loop (albeit a different one). Furthermore a difference should be made between a practically achievable circular economy and an ideal one, where the former tries to come as close to the latter as possible. Lastly, circular economic theory as it stands does not provide any feedback on where the ownership of resources should take place.

The last section of this chapter focused on establishing a definition of a circular economy as it was noted earlier that there is not one, single definition yet. This section came up with the following definition: ‘a circular economy is an economic system with cyclical material loops based on a financial incentive.’ Also some context and preconditions were given in order to ground the definition, and make it more than an ‘empty barrel’.
3. The construction industry and circular economy

*Sections 3.1, 3.3, 3.4 of this chapter are co-authored by R. Stigter (contact details can be found in appendix A)*

This section will describe general characteristics of the construction industry, this is done in order to be able to relate the construction industry to the earlier established definition of the circular economy. Although some products are already connected to the circular economy through for instance experiments of companies, there is little to no material to be found on the implementation of the circular economy in the construction industry (Bakker et al., 2014; Bom, 2012). This is despite of the fact that real estate is responsible for one third of global energy use, also 40-50% of raw materials that are used each year are devoted to the construction industry, and the sector accounts for 40% of solid waste streams (Antink et al., 2014). There is therefore a need to translate the circular economy to the construction industry. After the general description of the construction industry is made, this section will focus on what kind of effects the implementation of the circular economy might have on the construction industry. This will yield an overview of the issues that occur within the construction industry regarding this implementation.

3.1 Construction industry characteristics

The construction industry is typified by its project-based nature, it focuses on separate projects delivering different buildings (which are i.e. the end-products) (Vrijhoef, 2011). Where the building can be seen as a collection of different components that together form an entity that can be described as a building. A building is as such a collection of interrelated parts or components at different scale levels (Prins, 1992). Figure 7 shows the organizational model surrounding the realization of a building (partly deduced from Segerstedt and Olofsson (2010)), it can be seen that a building apart from forming a collection of parts, also forms a collection of stakeholders. These different actors all come together at a certain point in the building process in order to realize a building (which will be described below). It is important to keep in mind that the different stakeholders in a construction project have different needs and objectives for participating in the project (figure 7) (for the relations between the stakeholders see appendix B).

![Figure 7: Graphical depiction of a construction project with the different actors and their needs (partly deduced from Segerstedt & Olofsson, 2010).]
The project organization depicted in figure 7 does not create a building overnight, each construction project generally goes through several stages; these phases can be identified as: initiative, design, construct, and use. Where the initiative phase serves to define the need for a certain building or service, and the following design phase focuses on designing the need as it were. After the design has been made the process moves into the next phase, which is called the construction phase. In this phase construction of the design takes place, after construction is finished the use phase commences (Wamelink, 2010). What is worth noting is that these phases are designed to flow in one another like a circle, practice however learns that after the use-phase commences, little thought will be given to a new cycle (Yin & Menzel, 2011).

The construction process as described above seems neat and clear-cut, but it revolves around an intricate play of different stakeholders during different phases of the project. This makes for complexity, especially since the way in which the above stakeholders cooperate is different in every project, making each project a ‘one-off’ and unique (Segerstedt & Olofsson, 2010; Wamelink, 2010). What also becomes apparent is that on the supply side there are a lot of changes throughout the process when it comes to which parties are present in the project (see figure 8). There is not one single actor on the supply side that is present throughout the entire construction process. On the ownership side however, changes are relatively rare and if they occur, these changes were probably foreseen at the start of the project. It can therefore be argued that the ownership side of the process is more long-term oriented (with exception of the project developer), and the supply side more short-term oriented.

![Figure 8: Ownership and supplying parties in a linear construction process (Own image).](image)

Besides revolving around unique projects, the construction industry is also characterized by a relatively high amount of unique components that are being assembled in an artisanal way. There is not a lot of automation or generalization present in the industry (Eastman et al., 2008). Therefore a production chain like ‘make-to-stock’, which is common in other manufacturing industries, does not exist in the construction industry (Segerstedt & Olofsson, 2010).

A building is also characterized by a relatively long lifetime when compared to most consumer products, it is not designed to be replaced in two or three years. However a building is a sum of many components and these components all have different lifetimes themselves. A building is made out of hundreds or thousands of materials, all with different lifetimes, varying from a few months to hundreds of years (concrete, brickwork).

Furthermore the construction industry is capital-intensive, meaning that a lot of the costs (75%) can be traced back to material use and labour alone (Vrijhoef & Koskela, 2000). Or in
other words, the added value of delivered services is low when compared to the costs of the materials being used.

### 3.2 Developments in the building supply chain

Because of the fragmented nature of the construction supply chain, as was shortly explained above, different efforts have been made at supply chain integration and partnering amongst different stakeholders in the construction process. The idea behind it follows reasoning that can also be found in other manufacturing industries and will be explained below. Through this explanation it will also become clear why there, as of yet, has been no effective supply chain integration in the construction industry.

The main arguments for partnering and supply chain integration within the construction industry is that it would lead to; increased effectiveness and efficiency, commercial success, improvement of both joint and individual companies’ performance, and a better end-product (Vrijhoef, 2011). According to Bygballe, Jahre, and Swärd (2010) partnering can even be seen as the most significant development in improving project performance in the construction industry. This reasoning follows evidence witnessed from other manufacturing industries where these benefits have been observed (Vrijhoef, 2011).

Within the construction industry, the amount of partnering involved in a certain project is mostly covered by the form of the contract that is used. These contracts can take multiple forms but are generally classifiable into four different options; design and build, design build and operate, design build finance and maintain, and design build finance maintain and operate (Wamelink, 2010). These contracts determine the activities the supply side is responsible for delivering towards the client, whereby the latter forms mentioned require a higher amount of activities from the supply side than the former forms. Also in general it can be said that the more activities involved in the contract form, the longer the period the supplying parties will be committed to a certain project. In this way the contracts form a partnership between client and main contractor (who frequently represents the supply side during construction (Vrijhoef, 2011)), but leaves out any possible partnerships between the supplying parties themselves (Bygballe et al., 2010).

This while 75% of a building project is built in combination with suppliers and sub-contractors (Segerstedt & Olofsson, 2010). Contractors actually encourage partnering with clients, while at the same time opting for more conventional relations with suppliers and sub-contractors (Bygballe et al., 2010). This undermines innovation in the construction industry as innovation often comes from smaller suppliers whose role is being marginalised by these contract forms (Bygballe et al., 2010). The forming and use of many different relations with suppliers is actually a form of risk mitigation by the contractor (Segerstedt & Olofsson, 2010), and could explain why the construction industry relies on system-based trust instilled by the use of these conventional contracts (Bygballe et al., 2010). This system-based trust is used to counteract the unpredictability that is caused by the low levels of repetition apparent in the construction industry (Vrijhoef, 2011), and is another example of the short-term mind-set apparent in the construction industry amongst the supplying parties (Bygballe et al., 2010).

The demand side might however be (partly) responsible for this short-term mind-set. As Kornelius and Wamelink (1998) point out, products (i.e. a building) in the construction industry are investments, which explains the great client influence, and also the client can be very specific, undermining the incentive for a supplying party to come up with solutions that can be used in multiple projects. Also clients tend to look at initial price instead of total cost
of ownership (Fleming & Zils, 2014), further downplaying the incentive for supplying parties to look at long-term consequences. According to Bygballe et al. (2010), tendering and procurement regulations are the main reason for the short-term mind-set on the supply side of the construction industry. Here too, a demand side issue affects the mind-set on the supply side of the construction industry. To complicate matters further Vrijhoef and De Ridder (2005) refer to the client as most important in construction supply chain integration.

So why does supply chain management literature on the construction industry point towards the client as the most important actor in supply chain integration? The main reason seems to be the fact that supply chain management theory relies on the presence of so-called focal firms, these can be present on both the supply and demand side of an industry (Kornelius & Wamelink, 1998; Segerstedt & Olofsson, 2010; Vrijhoef, 2011). In the construction industry, the focal firm on the demand side is easy to be recognized as the client. On the supply side however, there is no generally accepted focal firm (Vrijhoef, 2011). In other manufacturing industries, like the car of aerospace industry, a focal firm shows ‘considerable dominance with an urge to excel’ in collaboration with supply chain companies, these supply chain companies are in turn highly committed to the focal firm (Vrijhoef, 2011). Such a firm does not exist in the current construction industry, instead contractors, developers, engineers, specialists, and suppliers could only act as a limited focal company (Vrijhoef, 2011). To overcome this lack of a focal firm on the supply side, literature points towards the demand side, and therefore the client, to realize supply chain integration in the construction industry. Despite the fact that a focal firm is seen as crucial in order to obtain the advantages of supply chain integration that were stated above (Vrijhoef, 2011). The absence of a supply side focal firm explains why supply chain integration in the construction industry has, as of yet, only managed to come up with informal, pragmatic solutions when compared to other manufacturing industries (Vrijhoef, 2011), and why supply chain integration is difficult in the construction industry.

3.3 Exercises in circular construction thinking
Under influence of the circular economy the way in which buildings are realised will change, this becomes clear when looking at the description and definition of circular economy in chapter 2, and by looking at examples of products in other markets that already claim to be circular (MVO Nederland, 2014; Deckmyn et al., 2014). As of yet there is however no precedent of what the construction process is going to look like under the influence of the circular economy. This section will therefore discuss current construction processes and their (in-)applicability with circular economy theory, this will be done through examining three different aspects that will be subject to change under the influence of circular economy implementation; ownership, business finance, and building components (i.e. the products). For these exercises the earlier established definitions and preconditions of a circular economy (chapter 2) are used, if any other assumptions are made these will be noted separately with each exercise. The result of these exercises yield an overview of the possibilities of implementation of circular economy in the construction industry, this section merely summarizes the results, for a complete overview of the exercises the reader is referred to appendix C.

Ownership in the circular construction industry
When circular economy theory is brought to the ‘standard’ construction process, the division between ownership and supplying party changes and becomes blurry. It can be argued that in this line of thought ‘traditional’ ownership disappears and shifts towards the supply side parties. This complicates the process as supplying parties, contrary to the traditional ownership parties are subject to change throughout the process and there would
therefore be a lot of different parties involved that can call themselves owners. It also affects the time scope of the involved parties, where supplying parties usually have a relatively short-term involvement and ownership parties a long-term involvement, in the circular process this division has disappeared, leaving the supplying parties to have to adjust their time scope to more long-term involvement. Leaving one owner would not solve this problem as well, as it undermines the incentives that drive the other suppliers in a circular economy.

**Business financing in the circular construction industry**

Leasing the objects constructed instead of selling them in order to retain ownership does not make sense from a contractor’s perspective in the current market situation and funding structures. This exercise shows that leasing impacts both the company’s liquidity and solvability in a negative way. It also causes a lot of deadweight capital in the form of solid assets on the company’s balance sheet. From the second year onwards, the company’s result would recover for the most part, however there would still remain a loss when compared to the conventional strategy, this is mostly influenced by labour costs. The current model where another party takes on these costs therefore makes sense.

A buy-buy-back model would diminish these negative results at the start of the timeline, but would replace the negative effects to later stages in the timeline. This option does therefore not offer a viable way around the problems observed above. Also reintroducing the product with low alteration costs at a later point in time becomes therefore difficult, as the leasing model puts a lot of strain on the company. The income and/or savings from reintroducing would therefore have to be of a considerable size in order to justify the leasing model.

**Building components in the circular construction industry**

Following this exercise it could be concluded that the more components there are involved in a building, the more difficult it gets to implement the circular economy principle (figure D4). With an increasing number of components significant organizational issues arise; all these components have to be maintained at different points in time. With this, also legal issues arise. For instance, it has to be clear who is responsible for the connections between components. Furthermore, contractors need to have knowledge of the connections with other components, preferably about the other component itself as well to make sure the maintenance process of one component does not compromise the functionality of the other. Concluding, flexible connections have to be designed keeping in mind the reachability issue as well (table D5 shows the main differences between the current and a (possible) circular situation).

### 3.4 Obstacles for implementation of the circular economy in the construction industry

This section will make a comparison between the three exercises that were made and earlier research on obstacles for implementation of the circular economy. This earlier research focuses on the implementation of the circular economy in general, it is not specifically done for the construction industry. In this way, this section will also make a comparison between the general obstacles and their relevance towards the construction industry. This will yield an overview of the obstacles that are relevant to the construction industry following the earlier made exercises (for the complete comparison and obstacles, see appendix D).
The general obstacles for implementation of the circular economy

The obstacles that will be discussed in this section were found by Kok, Wurpel, and Ten Wolde (2013) in an attempt to create a roadmap towards the circular economy. These obstacles are considered to be general and valid for all actors that want to partake in the circular economy, it is important to stress that this list is not exhaustive. All the obstacles can be found in table B1, as clear as these obstacles are, their generality makes them abstract and hard to place in specific contexts without further information. This also means that the roadmap created by Kok et al. (2013) does not specify its steps in the depth needed to be directly applicable to certain industries, or as the authors call it: ‘a transition without a blueprint’. Tying the previously elaborated exercises to these obstacles should therefore make them operational and define the problem at hand in the construction industry (although it needs to be noted that like the list of obstacles, the exercises are also not exhaustive). Please observe that Kok et al. (2013) also do not see sustainability as a separate category, but as a result of the circular economy (figure 9).

When comparing the exercises with the obstacles provided by Kok et al. (2013), it becomes clear that the problems surrounding the implementation of the circular economy in the construction industry reside along the categories ‘financial’ and ‘technological’. As figure 9 shows, almost all of the connections are to be found in these categories. The biggest match is however made with the institutional obstacle; ‘governance issues concerning responsibilities, liabilities, and ownership’. In the context of the construction industry it would however be more fitting to talk about an organizational obstacle at the level of the individual actors amongst themselves, therefore institutional is replaced by organizational in figure 9. There is one other obstacle that makes the same amount of connections as the organizational obstacle, namely: 'limited attention for end-of-life phase in current product design’, this obstacle was also found in all three exercises. It reflects the project-based processes that are common in the construction industry and the uniqueness of each building created, as was discussed in section 2.3. However this last obstacle is arguably less important than the institutional obstacle as one might infer that implementation of the circular economy should leave this obstacle immediately redundant. Another comparison with research done by Loppies (2015) also shows that organizational issues are present, along with technological challenges. This last comparison did not show financial challenges, this was however not researched by Loppies (2015).

Concluding remarks

Currently the construction industry can be characterized by its project-based nature, delivering unique products (buildings). Due to the uniqueness of its products, each and every
project in the industry is also different from one-another, with a different composition of stakeholders in each project. Also there is not a lot of thought given to end-of-life situations, probably because of the long time span surrounding the buildings, and the different components within the building have different lifetimes. Furthermore the industry is capital-intensive and relies a lot on manual labour in order to realize its products.

The second section of this chapter showed that the main arguments for partnering and supply chain integration within the construction industry are that it would lead to; increased effectiveness and efficiency, commercial success, improvement of both joint and individual companies’ performance, and a better end-product. Within the construction industry, the amount of partnering involved in a certain project is mostly covered by the form of the contract that is used. In this way the contracts form a partnership between client and main contractor (who frequently represents the supply side during construction), but leaves out any possible partnerships between the supplying parties themselves. This plays its part in the short-term focus of the supply-side parties in the construction industry, however the demand-side of the industry also plays a part in this short-term focus by the great influence the client has in a construction project. Despite this influence, the client is seen as the most important actor in construction supply chain integration. This however stems from the absence of a clear focal firm on the supply side in the construction industry, therefore complicating supply chain integration in the construction industry.

The third section of this chapter focused on three different short exercises that showed the practical implications of implementation of the circular economy in the construction industry. From these exercises it can be concluded that; when circular economy theory is brought to the ‘standard’ construction process, the division between ownership and supplying party changes and becomes blurry, it also affects the time scope of the involved parties. When it comes to business financing, it can be said that leasing the objects constructed instead of selling them in order to retain ownership does not make sense from a supplier’s perspective. Leasing impacts both the company’s liquidity and solvability in a negative way. It also causes a lot of deadweight capital in the form of solid assets on the company’s balance sheet. From the second year onwards, the company’s result would recover for the most part, however there would still remain a loss when compared to the selling strategy. Other strategies like a buy-buy-back model or reintroducing a product were also found to be unlikely profitable activities. When it comes to building components (i.e. the products) a shift in demands will be needed when circular economy theory is implemented. Furthermore, the amount of individual building components plays a role in the feasibility of the circular economy in the construction industry, where the more components inherent in a building the less likely it seems that circular construction is feasible.

The last section tied the exercises from the second section with general obstacles for implementation of the circular economy provided by literature. Through this comparison it has become clear that the biggest obstacle for the construction industry can be found at the organizational level, around issues concerning responsibilities, liabilities and ownership. This obstacle was found in all three of the exercises and other literature, next to that financial and technological obstacles play an important role in the construction industry.
4. Finding the incentive in the construction industry

This section attempts to tackle the organizational problem that was identified in chapter three as the most important obstacle when it comes to the implementation of the circular economy in the construction industry. In order to do so, this chapter builds on the earlier established definitions and obstacles for implementation that can be found in chapters 2 and 3. First this chapter will explain what kind of product needs to be offered in a circular construction industry, secondly this chapter will focus on finding the appropriate level of ownership within the construction industry. The last section of this chapter will introduce the appropriate level of ownership in a circular construction industry and explain why this is an appropriate level.

4.1 The product on offer in a circular construction industry

This section will describe the product on offer in a circular construction industry, this is important as this is a different product than the one that is currently on offer. This definition of a product follows the definition and concept of the circular economy as they were established in chapter two of this report.

In order to implement the circular economy in the construction industry it seems inevitable that the industry will have to start offering performances and/or services instead of a collection of components that can together be described as a building. It is otherwise not possible to make demand meet supply in a circular construction economy (see figure 10). Instead of offering materials, kilograms, and/or components, the industry will need to offer products that make it possible to offer a performance or service towards customers. De Grauw (2015) researched what performances and services should be offered and came up with the following definition: ‘A performance is an agreed upon action of performing that results in an output, utility, goal, function, or commitment whereby the product is not a goal in itself, but subordinate to the performance. Secondly, the service is mainly a non-physical action or operation whereby the performance is extended or optimized over time.’ In this research the following definition of performances and services will be used:

‘A performance is an agreed upon action of performing that results in an output, utility, goal, function, or commitment whereby the product is not a goal in itself, but enabling the performance. Secondly, the service is mainly a non-physical action or operation whereby the performance is optimized over time (adapted from De Grauw, 2015).’

Note that the term ‘subordinate’ is replaced by ‘enabling’ in the definition of a performance, this is because the term subordinate stresses a hierarchy between the performance and the product, while the performance cannot be delivered without the product itself. Therefore the term enabling seems like a better fit within this definition. Also the term ‘extended’ is removed out of the definition of a service, this is because it was established earlier in chapter 2 that life extension was not to be considered a loop within the circular economy. Furthermore, if life extension were to be the best option in any given case it would form an ‘optimization’, thereby also reflecting the possibility to neglect the term ‘extended’.
The change in the products on offer in the construction industry will in turn result in a change in the definition of a building; instead of a collection of components it will form a collection of products. The new definition of a building to be used in this research will therefore be:

‘a collection of products that together form an entity that can be described as a building. A building is as such a collection of interrelated products at different scale levels (adapted from Prins, 1992).’

Whereby the products enable the offering of performances and services to the demand side in the construction industry. This makes the building a dynamic ensemble of sub-systems instead of a static object. Whereby this flexibility is a means to being able to deliver various performances and services, not a goal in itself (adapted from Geldermans & Rosen Jacobson, 2015). This last addition is important with respect to the circular economy, as flexibility in itself loses its value in the circular economy if it is not geared towards a certain performance or service. This adapted definition allows us to look at the building from a viewpoint that is closer in relation to the concept of a circular economy.

4.2 The organizational problem as a problem of scale
If the concept of a circular construction industry is applied to the project organization model, it becomes possible to look at the different relations that will change under this influence. As was stated with the preconditions of the circular economy before, the appropriate scale level needs to be found for each specific industry for retaining ownership over resources. This is no different for the construction industry, therefore this section attempts to find this appropriate scale level. This is done through first analysing the problem in depth and secondly by incorporating some thought exercises comparable to the ones that were done in chapter three. After these exercises the appropriate level of ownership should be found.

The problem of different interests
If a look is given towards the organization of a building project, with the new definition of both a building and the product on offer as established above, it becomes clear that the earlier mentioned organization problem follows a problem of scale. As can be seen in figure 11, different parties in the construction project have their interests at different levels.

The suppliers, their sub-suppliers, and respective financiers have an interest at an individual product or service level. As for these parties the first incentive in participating in a construction project lies with business continuity (as was established in chapter three), their
main concern revolves around the products and services for which these parties are individually responsible, as these provide their business continuity. Therefore the building under construction in the project is of secondary concern to these parties. In this respect, also remember the lack of a focal firm and adherence towards such a firm in the construction industry, which reinforces the individualized incentives in this case.

Contrary to the interests of these parties, lay the interests of the contractor/developer and the real estate owners and these parties’ financiers. Their foremost interest is at the building level, this is also a result of their incentives for participating in the project. For a contractor/developer the building is the product that is being realized and could arguably be an investment or a source of business continuity. For the real estate owner and the financiers at this level, a building is an investment as part of a portfolio. For these parties their interest is therefore at the scale level of the building. This division in interests is relevant with respect to the circular construction industry as it explains some of the hurdles that were found through the exercises in chapter three. This will be explained below through two different thought exercises; ‘everybody is an owner’ and ‘ownership in between’.

![Figure 11: Depiction of the organization of a building project with different interests of actors depicted (own figure)](image)

_Everybody is an owner_

If the circular economy concept would be implemented in the construction industry with ownership over resources at the lowest level, the project organization would look like figure 12. In this figure the relationship between different actors and ownership of resources in the project is depicted through a dotted line. This way it becomes clear that there are a lot of different owners apparent in the project as was also established in exercise one of chapter three. So the ownership issue is not directly solved by choosing this scale level, furthermore this situation also bears a resemblance to exercise three which stated that the more components present in a building, the harder it would become to implement the circular economy. This is incorporated in this situation as well (only the components are replaced by products) with a similar outcome.
There would be a lot of different owners of the ‘building’ as all of the suppliers will retain ownership of their products. Seen from this project organization scheme it also begs the question whether the real estate owner and its financier will remain of added value, as the supplying parties within the project already cover ownership (figure 12). Keep in mind that a building in this research is seen as a collection of products instead of a collection of components (where some products could also be components, e.g. a façade component), further limiting the need for these parties. With many different owners there seems to be a need for coordination at the building level rather than at the individual product level.

![Figure 12: Depiction of the organization of a building project with ownership of actors’ own committed resources depicted (own figure)](image)

*Ownership in between (traditional option)*

The problem of scale could also be approached from a different angle. What if the ownership of committed resources would be held by one of the parties in between the suppliers and the building (i.e. the main contractor and developer)? Figure 13 describes such a scenario where ownership of resources is captured before it reaches the object under construction. This would eliminate the bundle of different owners that was found in the previously described ‘everybody-is-an-owner’ scenario, and provide coordination at the building level instead of the product level. Also within this scenario the question beckons whether there would still be a need for the real estate owner and its financiers in the organization model. Since ownership of the building is already covered by the contractor and/or developer.

However, this organizational set-up comes with some other problems. In the definition of the circular economy (that was introduced in chapter 2) the term ‘financial incentive’ is present, reflecting on the main trigger behind circular economy thinking. Placing ownership of committed resources at the contractor/developer level would eliminate this incentive for all the supplying parties on a level below that of the contractor/developer. It would not encourage them to attune their products towards a certain building any more than is the case at the moment, in a way maintaining the insufficient focal firms that can be found in the current construction industry. It would therefore be a continuation of a linear economy in the construction industry for each level below that of the contractor/developer. This would undermine the definition of a building as a collection of products that enables
performances and services, and make it impossible to implement the circular economy in the construction industry. Furthermore, as was established in exercise two earlier, it is hard for stakeholders at this level to currently offer circular products from a financial perspective. Therefore both from a conceptual as a practical viewpoint this does not seem to be the appropriate scale level to implement the circular economy in the construction industry.

4.3 The organizational problem solved through a ‘service provider’
This section will introduce the appropriate level of ownership of resources in a circular construction industry and explain why this is an appropriate level. For this appropriate level, a new entity needs to be implemented in the project organization scheme, as it followed from previous sections that the scale problem that is present within the construction industry is not to be solved by delegating ownership to one of the currently present stakeholders. In other words, this section will introduce a new entity at an (deemed) appropriate level and explain why this would be an appropriate solution.

The reason for implementing a new entity
Circular economy needs system optimization, new production processes, new ownership relations, networks and chains (Van de Kaa, 2013), furthermore the step from a linear towards a circular economy will increase the complexity of said processes, relations, networks and chains (Geldermans & Rosen Jacobson, 2015), while at the same time the need to work together will increase (Bastein et al., 2013). Many of these different factors could already be found in the thought exercises that were done in this research, underlining the above trends.

If a look is given towards chapter 3 of this research (especially sections 3.1 and 3.2) it becomes apparent that the construction process is already complex as well as the project organization. From the exercises in section 3.3 it becomes clear that under the influence of the circular economy, ownership will shift towards the supplying parties and the length of
their commitment to a certain project will increase. It also becomes apparent (through section 3.4) that when it comes to partnering and collaboration between the supplying parties, the construction industry is lagging behind other manufacturing industries. Partnering between the supplying parties is actually not deemed as important as the collaboration between the contractor and the client, and many partnering contracts focus on this relationship (Bygballe et al., 2010). Also the lack of a focal firm in the construction industry is complicating collaboration and partnering in the construction industry. In other words, the introduction of the circular economy in the construction industry would put more pressure on collaboration between the supply side parties for a longer period of time. This while the construction industry is historically unable to form partnerships between different supplying parties, due to amongst others the lack of a clear focal firm on the supply side. Implementing a new entity within the project organization (albeit only for research purposes) would create a clear focal firm for the supply side of the construction industry, eliminating existing barriers towards collaboration between the supplying parties in the industry. The new entity therefore provides an opportunity to study what the supply side needs to offer in a (idealized) circular construction industry without being hindered by current conventions.

**The position of the service provider**

The new entity that was referred to in the introduction of this new section will be called a ‘service provider’ from now on as it is positioned in between the supplying parties and the building and the other stakeholders present in the project organization (see figure 14). The general idea of a service provider is not new, in fact the Ellen MacArthur Foundation (2012) already implemented a service provider in their depiction of the concept (see figure 5). However the service provider as it is proposed here differs from the one that is proposed by the Ellen MacArthur Foundation (2012) in that the operations and all of the surrounding relationships of the service provider are the subject of investigation. This while the service provider as proposed by the Ellen MacArthur Foundation has a fixed position in the concept with fixed, unclear operations and relations, thereby surpassing deeper research into its role without properly understanding it.

Therefore this research offers, as explained above, a chance to design the role of the service provider without being hindered by current conventions (including the circular economy concept as it is laid out in figure 5). This role of the service provider would need to form the basis for solving the problems that were stated in previous section and incentivize the stakeholders in the right way following the definition of the circular economy that was provided earlier on in this report. The service provider is positioned at this particular point in the project organization scheme because:

- It follows from the previous sections that the service provider would need to be at the level of the building, as in this way it would overcome the earlier mentioned scale problem.
- At this particular point in the project organization scheme the service provider has ties to the contractor/developer as well as the other supplying parties (but does not automatically place one over another in the project hierarchy), as it became clear through earlier analysis that both are still needed but in a different way.
- At this particular point the different products of the supplying parties all come together.
Figure 14: Depiction of the organization of a building project with problem statement depicted (own figure)

The service provider would have to do so through effectively managing the two different transactions surrounding the service provider:

- The transaction between the service provider and the user
- The transaction between the service provider and the supplying parties

How these transactions are to be managed and what kind of form these transactions will take is the subject of further research of this report as well as the exact organization of the service provider itself. Along with these questions, also the question what current stakeholder could best perform the role of the service provider can be studied as well as the position of the owner and the financier.

**Concluding remarks**

This chapter consisted of three sections, the first section showed that a circular construction industry would need to offer products that make it possible for the supplying parties to offer a performance or service towards the customer. In this research the following definition of performances and services will be used: ‘A performance is an agreed upon action of performing that results in an output, utility, goal, function, or commitment whereby the product is not a goal in itself, but enabling the performance. Secondly, the service is mainly a non-physical action or operation whereby the performance is optimized over time.’ This will in turn lead to a new definition of a building: a collection of products that together form an entity that can be described as a building. A building is as such a collection of interrelated products and/or services at different scale levels (adapted from Prins, 1992).

The second section made clear that the organizational problem in the construction industry resides around a scale problem within the project organization. It has also become clear that this scale problem is not easily dealt with through delegating ownership to one of the parties that are currently present in the project organization scheme.
Therefore the third section illustrated that a new entity needs to be set up in order to be able to deal with this problem. Implementing a new entity within the project organization (albeit only for research purposes), would create a clear focal firm for the supply side of the construction industry, eliminating existing barriers towards collaboration between the supplying parties in the industry. The new entity therefore provides an opportunity to study what the supply side needs to offer in a circular construction industry without being hindered by current conventions. This new entity will be called a ‘service provider’ from now on as it is positioned in between the supplying parties and the building and the other stakeholders present in the project organization. With this position, the service provider role would form the basis for solving the problems that were stated in previous sections and incentivize the stakeholders in the right way. It would have to do so through effectively managing the two different transactions surrounding it:

- The transaction between the service provider and the user
- The transaction between the service provider and the supplying parties
5. Incorporating lessons from other industries

In chapter four it was established that in order for the circular construction industry to function properly, a service provider is needed. It was also found in preceding chapters that such an actor is as of yet not present in the construction industry. Therefore this chapter will take a look at other industries to see what can be learned and which of those lessons can be transferred to the circular construction industry. This chapter will look at two different kinds of subjects in other industries. Firstly, this chapter will look at the role of the service provider as it is fulfilled in other industries (because a service provider can be found in other industries), secondly this chapter will take a look at parties in other industries that claim to operate their business in a circular way. The third section will look at what lessons can be learned for the circular construction industry from the preceding two sections.

5.1 The role of the service provider in other industries

This paragraph elaborates upon the role of the service provider as it was introduced in other industries. This is because in other industries, just as was the case with the matter of integration within the supply chain, the role of the service provider is more mature (Schmenner, 2009). Although in those other industries the present service providers do not make use of circular economic concepts, they do offer a perspective on the functioning of such a role. Therefore the description of the role of the service provider as it is implemented in other industries forms the basis for a comparison between these other industries and the construction industry. And therefore to see if certain elements that are in use in other industries can also be implemented in the construction industry. In order to make this comparison possible, first the reasons as to why a service provider is present in other industries are elaborated upon. The section thereafter will present the activities the service provider performs in those other industries, followed by a section that examines the characteristics of those other industries. Afterwards the final section of this chapter will introduce the lessons that can be learned for a circular construction industry.

The role of the service provider in other industries

Before a deeper look is taken at what kind of activities a service provider performs in other industries. It is useful to take a look at what kind of party the service provider is in other industries. Baines and Lightfoot (2013), Biege et al. (2012), and Tukker (2004) make a distinction between pure service providers and manufacturing service providers. Whereby the first form focuses on delivering services without having any physical, underlying product (e.g. consultancy firms), and the latter form offers a combination of a manufacturer and the first form. This makes the last form a crossover between a pure manufacturer and a pure service provider, which offers services based on underlying products. The offering of services based on underlying products shows close relevance to the earlier established definition of a building and that of performances. It is for this reason (and for more reasons that will become apparent in the next few sections) that this crossover form is most relevant for the circular construction industry, and will be studied in further depth in the next sections.

Why is the service provider present in other industries?

Since circular economy is a relatively new concept, the examples of service providers that can be found in other industries feature this role without the circular economic concept. Therefore there must be other reasons for this kind of party to appear, this section will introduce these reasons. To do so, use is made of a research about ‘servitization’ made by Baines and Lightfoot (2013). Through this research they found that a service provider appears in an industry because of five different perspectives;
• **An economic perspective**
  From an economic perspective services and the aftermarket represent an alternative strategy as opposed to producing new products, thereby offering the manufacturer a way to distinguish itself from its competitors. This argument mainly follows from the substantial installed base of products (already in the field), intensifying the need for this diversification (Bastl et al., 2012; Biege et al., 2012; Fang et al., 2008; Gebauer & Friedli, 2005; Oliva & Kallenberg, 2003; Windahl & Lakemond, 2006). Furthermore, the commercial benefits of servitization can be significant as profit margins for services are potentially 2-3 times greater than those for products, increased customer loyalty may appear, and improved resistance to outsourcing might be realised (Fang et al., 2008).

• **An environmental perspective**
  Interestingly, without a direct connection between the research of Baines and Lightfoot (2013) and the concept of circular economy, it is found that environmental reasons offer an incentive for producers to make use of a service provider. It is also interesting that the given arguments are relatively the same for implementing circular economy in practice, as Baines and Lightfoot (2013) recognize that servitization interplays with; global concerns about population, resource exploitation, and consumption. But also the fact that developed economies can set an example by doing more with less, as services enable dematerialization, and can positively impact environmental sustainability, and that there are opportunities to improve ‘green’ credentials through the use of services are seen as possibilities.

One of the possible explanations for this focus on sustainability comes from the different research fields that have contributed to this topic. One of these research fields is the, relatively new, product-service systems community that sets out to: ‘improve social, economic and environmental, and industrial sustainability’. Which are goals that sound familiar to the circular economic concept as it was introduced in chapter two.

• **A market and social perspective**
  From this perspective it is acknowledged that products and services do not necessarily compete (although this might occur (Bastl et al., 2012)), rather products can create platforms for new services (e.g. Apple and the launch of iTunes). Entering the services market as a manufacturer might however mean facing ‘new’ competitors from the services market. However manufacturers are expected to enjoy the following advantages over these ‘new’ competitors; lower customer acquisition costs, lower knowledge acquisition costs, and lower capital requirements (Oliva & Kallenberg, 2003). Besides, in a more fundamental way, the extent of services activities is directly linked to the wealth of an economy.

• **A technology innovation perspective**
  Through information and communication technologies many services are enabled in an accessible and affordable way.

• **A knowledge perspective**
  There is a change in attitude of suppliers towards the consumer. The idea that value is co-created with customers, rather than being embedded in products is for instance gaining traction amongst producers (Jonker, 2015). Also differences between services and manufacturing operations are better understood. Also,
producers recognize that a holistic approach is needed where a look is given at the ‘service’ as a system of interacting parts that include people, technology, and business as a whole.

It is interesting to see that many of the perspectives as they were presented in the above section correlate to the concept of the circular economy or to the definitions and requirements as they were introduced earlier on in this research. It is however important to note that the economic perspective prevails as the main reason for the provision of services in literature. As a matter of fact, the economic perspective already became apparent in the late 1800’s in the United States (Schmenner, 2009). As noted earlier, the service providers that are observed in literature today do not make use of a circular economic concept, they mostly exploit the economic perspective. It is indeed possible to obtain financial gain from offering services, however for this gain to have any impact on the company that offers these services, the provision of services needs to be a substantial part of the company’s operations (20-30% at least) and the services need to be related to the provider’s core business (Fang et al., 2008). This indicates that in order for service provision to become effective, considerable investments might be necessary, which might be one of the reasons manufacturers might be reluctant in adopting them (Tukker, 2004). With respect to the environmental perspective (together with the economical perspective the most relevant perspective with respect to the circular economy), it can be said that it is not completely clear whether the prescribed environmental gain can be realized through the provision of services. Research done by Tukker (2004) shows that, when the offered services focus solely on the product (e.g. maintenance) the environmental improvement will be relatively modest (10-20% when compared to the non-service scenario). Higher environmental gains are however to be expected of services that are result and/or ability-driven.

**The kind of services offered by the service provider**

This section will give a closer look at what kind of services are offered by a manufacturing service provider, as not every service provider offers the same kind of service(s). In order to enable a closer look at these services, multiple frameworks are available. One frequently used framework is introduced by Tukker (2004), and distinguishes; product-oriented, use-oriented, and result-oriented services. However, this framework does not offer clear examples of what activity is understood to be a particular service. Therefore this research will make use of the framework offered by Baines and Lightfoot (2013), that divides services into; base services, intermediate services, and advanced services (see figure 15).

What becomes apparent when looking at figure 15 is that there are significant differences between the three kinds of services, whereby the advanced services are most deeply integrated into the customer’s business. Base services are already offered by many manufacturers and do not require any alteration of the manufacturer’s business model (more on this in later stages of this chapter). Intermediate services go a step further and require the manufacturer to set-up additional business units that can perform these services. Lastly with advanced services the manufacturer will go a step further again, most noticeably the manufacturer will retain ownership over its deployed product and bases its services around this deployed product. This is concurrent with circular economic thinking as it was laid out in previous chapters.
How the service provider provides its services

The service provider provides its services to the customer through a product-service system (Biege et al., 2012; Tukker, 2004). In literature this system is named by De Grauw (2015) as a way of delivering services in a circular construction economy. However De Grauw (2015) finds this system insufficient when talking about a circular construction industry and develops a performance-service system. When De Grauw’s system is compared to the product-service system as it is introduced by Baines and Lightfoot (2013), they show similarities in their approach with respect to the marketability of the offered services. Since the product-service system as introduced by Baines and Lightfoot (2013) is however more complete and worked out in detail, this will be the system that is elaborated upon in this research (the product-service system as laid out by Tukker (2004) is not adopted here for the same reason as it was not used to indicate differences between services as described in the previous paragraph).

The product-service system comprises both the product and the services that are acquainted to it. The part of the product-service system that is under responsibility of the manufacturer is called the service delivery system. Within this service delivery system the main focus for the manufacturer is on two capabilities; (1) an ability to respond cost effectively, and (2) an ability to improve cost effectiveness. The focus on these two capabilities is distinctly different from the ‘usual’ focus of manufacturers and stems from the notion that within the product-service system it is the manufacturer that is responsible for extra costs arising when its products do not live up to their customer’s expectations (figure 16). It is important to note that this is a similar mechanism that is mentioned in circular economy theory as outlined in chapter two, where it is in the manufacturer’s own interest to design its products in such a way that they are easy to disassemble as the manufacturer will face the costs of this process.

Figure 15: The division into three different types of services (source: Baines and Lightfoot, 2013)
Within the product-service system, the advanced services provider might need to stretch its business. Whereby the stretch of the manufacturer’s services depends upon the core activities of the customer for the ‘forward’ stretch and upon the core activities of the manufacturer for the ‘backward’ stretch (Bastl et al., 2012). An example is given by Baines and Lightfoot (2013) in a case that represents the economic model of Alstom (A train manufacturer) that performs the capability of ‘passenger transport’ for a transport company (figure 17). Alstom stretched its services as far around the train (i.e. the product) as designing and manufacturing it, monitoring it, maintaining it, and repairing it, and also taking it back after use (numbers 6,7,8,9,10 in figure 17). In order to be able to perform these services for the customer, Alstom makes sure that all knowledge surrounding these services is available within its own organization. If knowledge was not available in its own organization before this particular project, Alstom acquired third parties that inherited that knowledge or developed this knowledge in-house. This shows that there might need to be a significant organizational stretch by the manufacturer, if the required capabilities are not present within the organization, in order to be able to offer these services (Note the similarities with vertical integration and supply chain management in the construction industry as discussed in section 4.2). Alstom’s organizational stretch could have easily included offering its own drivers to operate the trains, this is however perceived as a core task by the customer and is therefore not offered by Alstom. This shows that offering advanced services asks for careful coordination and communication with the customer in order not to engage in the customer’s core activities (Windahl & Lakemond, 2006).

The effect of service provision on the relationships within the service provider’s network

Through the foregoing section it became apparent that the decision to provide services might have some considerable effects upon the operations of the service provider, it also became clear that these effects might have an effect on ‘upstream’ suppliers too. Through literature it becomes clear that the actual relationship between suppliers and the service provider might change as a consequence of service provision (Bastl et al., 2012; Oliva & Kallenberg, 2003; Windahl & Lakemond, 2006). Upstream suppliers might for instance be better suited to perform certain services themselves instead of the service provider, this could cause competition between the service provider and the upstream supplier on the
same product (Bastl et al., 2012). However trying to avoid this ‘internal’ competition by blocking the upstream supplier from interacting with the client directly might cause the supplier to not being able to see the benefits of participating in the integrated services, possibly leading to lower commitment on the supplier’s part (Windahl & Lakemond, 2006). As a consequence, there has been an increase in the amount of complex contracts in order to be able to deal with the risks associated with these situations. Evidence from literature however shows that this increase in contracts tends to block business operations from happening in the first place, because of vagueness surrounding responsibilities. A combination between governance through contracts and relational governance (e.g. trust) is therefore needed (Bastl et al., 2012, Windahl & Lakemond, 2006). On the demand side of the service provider’s network it is important to already have a client in early stages of every project, this as the solution the service provider needs to deliver will be tailored and therefore client-specific. Without a particular client, it will be difficult to gear a particular solution towards a clear goal (Windahl & Lakemond, 2006).

![Figure 17: Economic model of figure 16 exemplified through the Alstom case (Baines and Lightfoot, 2013)](image)

**What kinds of industries use a service provider?**

The book of Baines and Lightfoot (2013) elaborates upon four cases in particular; (earlier mentioned) Alstom, Rolls Royce (manufacturer of aeroplane engines), Caterpillar (manufacturer of mining machinery), and Xerox (manufacturer of printing devices). Another example can be found in the form of the merger between LIPS and Wärtsilä (propellers and boat engines) in research done by Huurdeman (2015). Although these five examples are all based in different industries, there are some similarities between them. They are all based in established fabrication industries, and they produce homogenous products. Furthermore, all five manufacturers have deliberately chosen to compete in the market with services instead of their products alone. In this way the manufacturers attempt to differentiate themselves from competitors.
5.2 How do circular companies operate in other industries?
This paragraph elaborates upon the operations of companies that already made their business circular (or at least claim that their business is circular). As mentioned before examples of circular companies are rare, examples in the construction industry are even more rare. To complicate matters further as was visible in chapter 2, the terminology of the circular economy is not mature either. However it was established that the concept of cradle-to-cradle shows similarities with the circular economic concept (apart from the characteristic incentive shift), therefore this paragraph will look at both (self-)claimed cradle to cradle and circular economic companies either in- or outside of the construction industry. As these parameters are rather wide, direct comparisons with a possible circular construction industry are hard to make. Therefore it is important to note that the role of this section is more focused on inspiration and the wider framework surrounding the circular economy.

Why are companies currently operating in a circular or c2c fashion?
First, this section will take a look at the reasons as to why companies pursue sustainability in the first place. Research by Dangelico and Pujari (2010) shows that companies integrate sustainability into their business for three different reasons (which can all be relevant at the same time). The first reason is to comply with regulations, this as governmental regulations are steering more and more towards sustainability. The second reason is to improve the competitiveness of a company, particularly sustainable products are seen as a way of improving competitiveness through better reputation and image of a company. Thirdly, ecological responsibility is seen as a reason to opt for sustainable strategies. There is a consensus between the companies studied by Dangelico and Pujari (2010) that it is important to actually deliver upon the sustainable promises made by the company, as a lack of credible and verifiable ‘green credentials’ might have public or stakeholder repercussions. Therefore sustainability is preferably implemented at the core business of companies that pursue these kinds of strategies, as can for instance be seen in different case studies (appendices G, H, I).

Through these case studies it becomes clear that there are different reasons for companies to operate in a circular or cradle-to-cradle way. Some companies have embedded this type of thinking into their core strategies, others take sustainability more as a more holistic concept and think of circular economy or cradle-to-cradle thinking merely as a part of this holistic concept. All example companies however thought of sustainability (whether it was in a circular way, cradle-to-cradle inspired, or in another way) as a way to create a unique selling point for their company.

With the use of different concepts, also the way in which the example companies implement the circular economy differs somewhat. In all cases however, it becomes clear that the involved companies are looking for a way to deal with the financial incentive (as follows from the circular economic concept as it was introduced in chapter two).

How do other companies operate in a circular or c2c fashion?
After the introduction of the different reasons as to why companies operate in a circular or cradle-to-cradle way, this section will focus upon how these companies go about their business. In order to do this, a look will be given at their products, market, sustainability concept, supply chain, and client solutions. After this section it will be clear to the reader how the aforementioned points are dealt with in the case companies.
<table>
<thead>
<tr>
<th>Aspect</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>BMA Ergonomics</strong></td>
</tr>
<tr>
<td><strong>Product(s)</strong></td>
<td>Circular office chairs</td>
</tr>
<tr>
<td><strong>Market (as a whole)</strong></td>
<td>Low-tech, lot of competitors, low on innovation</td>
</tr>
<tr>
<td><strong>Sustainability concept</strong></td>
<td>Stems from cradle-to-cradle, has moved towards circular economy</td>
</tr>
<tr>
<td><strong>Supply chain management</strong></td>
<td>Close supplier monitoring and auditing following own standards by itself</td>
</tr>
<tr>
<td><strong>Client solutions</strong></td>
<td>Offers clients a buy-buyback model on its office chairs</td>
</tr>
<tr>
<td><strong>Product Monitoring</strong></td>
<td>No product monitoring apparent</td>
</tr>
</tbody>
</table>

Table 3: Business operations of case companies (Source: Appendices G, H, I)
In table 3 it becomes clear how the case companies (appendices G, H, I) deal with certain aspects regarding their circular or cradle-to-cradle operations. It immediately becomes clear that the case companies operate in different industries and that, as mentioned before, their view on sustainability differs too.

But although the views on sustainability within the companies differ, the focus on sustainability within the companies has led to some similar effects. In particular the focus on sustainability among the case companies has led to closer supply monitoring. Usually this involves the supplying parties to pass requirements that are imposed by the manufacturer and audited on a regular basis (either through the manufacturer itself or a third, specialised party). What can also be seen is that in their search for circular business operations, two of the reviewed companies have moved towards either leasing, or buy-buyback models in order to place the financial incentive at the correct place. So even though the original outlook of the companies might not be circular, they are moving towards operations and activities that are in line with circularity. A final point is that two out of three case companies are now monitoring their products during the use-phase of these products in order to ensure optimal performance of these products. This analysis is pictured graphically through figure 18, and shows these lessons learned in this paragraph.

![Figure 18: Circular process as observed at case study companies (not all of these activities are present at all of the case study companies) (source: own image)](image)

In what kind of industries are these circular and c2c companies operating?
This section will focus on the characteristics of the other industries where these companies are present. The focus in this section is more upon the characteristics of the products offered in these industries as a brief market description was already provided through table 3.

In all of the industries of the case study companies the products on offer in general are quite homogenous. The basis of each of the products, whether it is an office chair or carpet or a baggage-handling system, will not diversify itself from products offered through competitors. Only maybe some design, or material decisions might offer a competitive edge. By offering services alongside the products as well as a focus on sustainability, the case study firms are looking to differentiate themselves from competitors.

### 5.3 Lessons to be learned for the circular construction industry

This section will elaborate upon what can be learned from the preceding sections of this chapter for the circular construction industry. These lessons can afterwards be incorporated or taken into account when developing a business model for the service provider in a
circular construction industry. This section will start out with general lessons on the circular economy, followed by specific lessons learned for a circular construction industry.

**Lessons to be learned for the circular economy**

This chapter also showed some lessons to be learned for the circular economy in general. Especially the fact that many service providing companies already have the operations in place as you would expect to find them at a circular company (section 5.1), without use of the circular economic concept. This has led to figure 19, which features an incorporation of the service levels as distinguished by Baines and Lightfoot (2013) (see figure 19), and the circular economic concept.

![Figure 19: incorporation of the circular economic concept with the service levels as distinguished by Baines and Lightfoot (2013) (see figure 15), hereafter referred to as the 'circular service level framework' (source: own image)](source: own image)

On the horizontal axis of figure 19 the different service levels are placed (for a more detailed description see figure 15), the higher something is placed on the vertical axis, the more or higher it is. To illustrate the functioning of this graph consider the following: if a client or customer opts to acquire a product with basic- or intermediate services, the ownership of that product and therefore the circular responsibility will lay with the client or customer (as these represent the acquiring party). If on the other hand the client or customer opts to acquire a product through advanced services, the ownership will lay with the manufacturer or producer of that product, and hence the circular responsibility. With this graph the chosen service level is always dependent upon the client, as is logical in a demand-driven economy. This is because if reasoning were followed from the other way around, (and i.e. the supplier would choose this service level) we would speak of a supply driven economy.

The functioning of the graph (hereafter referred to as the circular service level framework) is illustrated by the case study companies that were examined under section 5.2. Desso’s approach of the circular economy so far for instance, has entailed the provision of basic services to the client as it merely focused on deploying the product into the market and (optionally) taking it back again at the end of the product’s lifetime. Therefore it leaves the responsibility to deal with the delivered product in a proper way with the client or customer, if this party does not return the product to Desso, the circular loop will not be closed. This brings up the following point to be clarified about the graph, namely the dotted lines. Since there is no way that Desso in the above example is certain about closing the loop a further action is required, it would need to sign a contract (or agreement of intention) with the client that it returns the product to Desso at the end of its lifetime (based on the assumption that it is beneficial for both parties to do so). Therefore the more basic the services, the more detailed this kind of contract needs to be in order to keep the loop going. If on the other hand Desso would implement its lease strategy, therewith offering an advanced
service, the need for these contracts will decrease. This is because when Desso does not optimize its product for return at end of life, it will face the costs for this inefficiency by itself. Therefore also the amount of vertical integration is likely to rise when use is made of more advanced services, as the service providing company would need to ‘stretch’ its organization (see section 5.1) as far as needed in order to be able to deliver its services in the most efficient way. Similar kinds of exercises can be made for the other case study companies, with the same results.

There is also an example to be found from the ‘circular’ construction industry in relation to the circular service level framework (figure 19). The Tenet case study (appendix F) illustrates what is needed in order for a project to be circular when the client only requires basic services (or intermediate services, if repair is taken into account). One of the involved consultancy firms in the project, introduced demands upon the parties that were competing in the tender (a detailed description about these demands can be found in appendix F). These demands were made to insure that the bidding companies adhered to the cradle-to-cradle requirements as set out by the client and were enforced through contracts. This shows that contracts (or agreements of intention) are needed in order to make a project circular when the client merely opts for basic services. During the lifetime of the delivered products, suppliers are also required to register any additional material they might use during repairs. At the end of the product’s lifetime (which in this project is determined to be as long as the financial write-off on the products), the client is responsible for keeping the products ‘in the loop’. How exactly this should be done is not clear as of yet, and if the client steps away from its circular obligations this might be hard to counteract legally (appendix F). This last uncertainty is also what makes this project not circular in that particular situation, as the loop is not closed, this case does however illustrate the functioning of the circular service level framework (see figure 19).

In a way the above explanations surrounding the circular service level framework (figure 19) confirm the stance of construction supply chain management literature on the client as being the most important actor in supply chain integration. However it also shows that the client might hinder supply chain integration, as one could argue that for basic services no further supply chain integration might be needed. The situation as outlined in section 5.2 will therefore hold in the situation where circularity is arranged through basic- to intermediate services. When a client opts for more advanced services to establish circularity, the earlier described organizational ‘stretch’ might need to take place (depending upon the amount of available internal skills (Fang et al., 2008)). In this situation the client indirectly (through opting for a certain service level) will most likely increase supply chain integration and therefore confirm the general opinion present supply chain management literature. In short, there are multiple ways to go about the circular economy. These ways are dependent upon what service a client wants to receive with a certain product, these could either be base, intermediate, or advanced services (although advanced services show the highest affinity with the circular economic concept (as it was introduced in earlier chapters)). The chosen service level greatly impacts the processes that are needed in order to implement the circular economy in a certain project, and therefore also impacts the organization that is needed in order to be able to deliver these services.

At this point a note of caution is in place, as through coupling the different service levels of Baines and Lightfoot (2013) and other literature on the provision of services with the circular economic concept (see figure 19), one might get the impression that in order to be circular a certain company could just act like the observed companies in other industries. This does not necessarily have to be true, since the observed service providers do not (as far as the
knowledge of the author is concerned) design their products in a circular way. It was acknowledged however, that they showed behaviour as it is to be expected of a circular company. Therefore, the idea might appear that these service providers could take this step without any problems. However, as the observed service providers do not offer circular products, it is impossible to say whether they could do this and still remain as profitable as they are now through the provision of services (since products need to be taken back, and possibly altered at the end of their lifetime). These costs are currently not incurred by the observed service providers. Therefore it can be stated that this final step will only certainly be beneficial when resource prices are on a constant rise (as it would then be beneficial for the circular service provider to re-use installed resources instead of acquiring new resources). If these resource prices are not on a constant rise it comes down to the ability of the circular service provider to be more efficient in using circular materials as opposed to using new resources, in order to make the circular business operations not more expensive than the linear model. This might incentivize the circular service provider to return to linear operations as the financial incentive might disappear (e.g. in a case where resource prices drop instead of rise over time). Therefore the idea that by simply providing an incentive shift (through a lease solution for instance), circularity and thus sustainability are guaranteed does not hold under certain conditions. In order to guarantee sustainability in case of sliding resource prices, additional contractual requirements would need to be in place (if the service provider does not sustain circular operations when they are not as profitable as linear operations), that tie the circular service provider to its circular business operations. This observation links-up with the definition of the circular economy as it was introduced earlier in this research, and leads to the statement below:

‘Circular economy is a business strategy that, if governed correctly, is sustainable’

Please note that it in the described situation it might still be profitable for the service provider to offer services towards the client, it could however be that sustaining circular business operations might not be due to costs incurred in dealing with circular materials.

Lessons learned for the circular construction industry

The first section of this chapter that focused on the role of the service provider showed that some of the different prerequisites for the circular construction industry are already in place in other industries. However interestingly, these other industries do not make use of the circular economy concept. A direct comparison between these other industries and the construction industry is therefore not possible. The following points can however be made with regards to the circular construction industry:

• Offering ‘capabilities’
Just as with the circular economic concept, the focus for (manufacturing) service providers is on offering ‘capabilities’ that are based on the manufactured product. These capabilities are delivered through services that are required to achieve a certain performance. Through offering capabilities it is most likely that the high sustainability aims of the circular economy concept can be realized.

• Relationships between actors in a product-service system
From circular economic theory (as introduced in previous chapters) it follows that the relationships between suppliers will be different and are of increasing importance. From the examples from other industries it shows that the use of a (manufacturing) service provider has caused different relationships, for example with financiers (as becomes clear through figure 16). In these other industries the
use of a product-service system has also led to a tighter relationship between suppliers and in some cases integration of suppliers into the main manufacturer’s business. Furthermore it is important to have a committed client in the early stages of a project, otherwise it can be difficult to develop a client-specific, ‘tailored’ solution.

- **Disappearance of scale benefits**

Offering ‘capabilities’ to clients instead of pure products has resulted in a more client-specific approach by the manufacturer (at least in the reference industries). This might be seen as a logical consequence of ‘tailoring’ services for one specific client in order to offer the client the capabilities that are agreed upon (Oliva & Kallenberg, 2003). This also entails that scale benefits might be reduced, as the manufacturer needs to undertake activities specifically for a certain client. As became apparent through earlier chapters there are not a lot of scale benefits to begin with in the construction industry (every project is unique), therefore this factor might not refrain parties in the construction industry from going circular (hence, going circular will not show a dramatic impact on these scale benefits).

The second part of this chapter focused on several case study companies. This section revealed that as these firms are operating now, neither of them qualifies for delivering advanced services at this moment. Instead most of them deliver intermediate services, in that sense they do not offer fair comparison material. However, it can be said that in all cases these firms operate in established fabrication industries with homogenous products, and are looking to differentiate themselves through offering services. Furthermore they have taken some similar steps in order to implement sustainability into their business operations. These steps showed themselves to be similar to those in the first section; a tightening of the relation between supplier and manufacturer, and the offering of ‘capabilities’ through services.

**Concluding remarks**

In this chapter a look was given at other industries to see what could be learned, and which of those lessons could be incorporated in the circular construction industry when it comes to the role of the service provider and circular business operations. The first section dealt with service providers that are present in other industries and showed that first; a distinction needs to be made between pure service providers and manufacturing service providers. It followed from their characteristics that the ‘manufacturing service provider’ shows the closest resemblance to the circular economic concept. Furthermore this chapter showed that, servitization occurs in other industries (without the circular economy concept) because of five different perspectives; an economic perspective, an environmental perspective, a market and social perspective, a technology innovation perspective, and a knowledge perspective. Within these perspectives the arguments that are used for servitization sound familiar, as they are more or less the same as the arguments that were introduced around the circular economic concept in chapter two. Although it needs to be said that the prevailing argument in literature for servitization is the economic perspective as outlined earlier, with respect to the environmental perspective it can be said that the inherent potential differs for the kinds of services that could be offered. Next, this section took a closer look at the operations of the service provider in other industries through explaining that there are three types of different services that a service provider can offer: base, intermediate, and advanced services. Advanced services showed to have the highest affinity with circular economic theory as it has been laid out in earlier chapters. These advanced services are delivered through a product-service system in which the focus for the
manufacturer is on: (1) an ability to respond cost effectively, and (2) an ability to improve
cost effectiveness. In order to be able to deliver on these two main capabilities the
manufacturer has to ‘stretch’ its organization as far as is needed, without impeding on the
customer’s core business and with careful consideration of its suppliers. Although the
characteristics of the different comparison industries are different from the construction
industry, certain common elements between the service providing companies in these
industries can be found. For all of these companies it was found that in all cases these firms
operate in established fabrication industries with homogenous products, and are looking to
differentiate themselves through offering services.

The second section of this chapter focused on different case studies, were it became
apparent that there are different reasons for companies to operate in a circular or cradle-to-
cradle way. In all cases it became clear that the involved companies are looking for a way to
deal with the financial incentive. Even though the viewpoint of the studied companies on
sustainability is different, some similarities emerge in their business operations as a
consequence of this sustainability focus. Every case study company engages in tighter supply
chain management and starts to offer services based upon their products. Furthermore two
out of three case study companies also started product monitoring during the use phase of
the products in order to ensure optimal functioning of these products. In all of the industries
of the case study companies the products on offer in general are quite homogenous. By
offering services alongside the products as well as a focus on sustainability, the case study
firms are looking to differentiate themselves from competitors.

The third section of this chapter elaborated upon what can be learned from the preceding
sections of this chapter for the circular construction industry. The first part focused on
general lessons to be learned about the circular economy, where it was found that there are
multiple ways to go about the circular economy. These ways are dependent upon what
service a client wants to receive with a certain product, these could either be base,
intermediate, or advanced services (although advanced services show the highest affinity
with the circular economic concept). The chosen service level greatly impacts the processes
that are needed in order to implement the circular economy in a certain project, and
therefore also impacts the organization that is needed in order to be able to deliver these
services. Furthermore it was found that under certain circumstances, an incentive shift alone
might not be enough to ensure circularity. The second part of this section focused on lessons
to be learned for the construction industry, and found (in concurrence with earlier findings
about the circular economy) that the service provider in a circular construction industry
would need to: offer capabilities towards clients, change its relationships with suppliers, and
needs to take note of a possible disappearance of scale benefits as they might be present
now.
Part III: Business model prototypes
6. Designing the service provider’s business model

After the previous chapter has elaborated upon the ways in which a service provider and a ‘circular’ business can operate, this chapter will make an attempt at designing a business model for the circular construction service provider. This design will be based upon knowledge that was gained in previous chapters. The goal here is to design multiple variants of business model prototypes for the circular construction service provider. In order to be able to design these prototypes, the first section of this chapter will focus upon what the service provider needs to do according to circular economic theory. The second section of this chapter will focus on the business model framework that will be used. The third section will introduce the different variants of business model prototypes for the circular service provider in the construction industry. The final section will analyse the developed business model prototypes with earlier theory in this report.

6.1 The service provider according to circular economic theory

This paragraph elaborates upon the role of the service provider as it was introduced in earlier sections of this research. It will do so by first identifying the service provider that is under investigation in this research, as it followed from chapter five that there are different kinds of services that could be delivered in a circular economy. Thereafter this section will introduce the product the service provider has to offer towards clients, the requirements that need to be in place in order for the service provider to function properly, and the business operations that belong to the service provider in a circular construction industry. This role description follows from the earlier chapters of this thesis and other literature on the circular economy. It is important to note that although this literature does not necessarily attribute these requirements and responsibilities to the role of the service provider directly, they are registered as needed in a circular construction industry.

The type of service provider under investigation in this research

From the previous chapter it followed that there are different kinds of services that can be offered in a circular economy, in order to prevent confusion this section will elaborate upon the kind of services that are under investigation in this research, and the reason as to why these are under investigation.

![Figure 20: the circular service level framework, with the consequences for the kind of cooperation (contracts) between service provider and client (source: own image)](image)

If a look is given to figure 20 it becomes clear what consequences the chosen level of services has for the kind of cooperation between the service provider and the client. If the
client opts for base- to intermediate services, possible solutions for circularity can be found in for instance buy-take back or buy-buyback constructions with the service provider. If on the other hand the client opts for advanced services, possible solutions for circularity can be found in for instance financial or operational lease constructions.

This research will focus on designing a business model for the circular delivery of advanced services. This will be done for several reasons:

1. An advanced services model is as of yet not present in the construction industry.
2. The previous chapter found that offering capabilities (which would occur through advanced services) show the greatest potential for profitability and sustainability gains (mainly through the previously described incentive shift).
3. In order to deliver circular products through base to intermediate services, the service provider needs to engage in similar activities as if it would offer advanced services. It would for instance still need to have an in-depth knowledge of its products and of the product capabilities to be re-introduced in another cycle at the end of its lifetime (in order to close at least one circle).
4. Examples in the construction industry where base to intermediate services are offered are already present (repair in this case). The Tennet-case provides an example of this approach, albeit that the manufacturers are not that tightly bound to take back their products (figure 21, appendix F). If those issues were to be overcome, this case would illustrate an almost textbook example of how such a model could work (without any major changes to existing business models).

Therefore this research will not focus on solutions for base- to intermediate service delivery in the circular construction industry but on advanced service delivery solutions.

![Diagram](source: own image)

**Figure 21: the circular service level framework with the known examples of a circular construction industry**

*The product offered by the service provider*

Before describing the role of the advanced service provider more in depth, it is first necessary to know what product the service provider has to offer. This section will introduce this product that needs to be offered by the advanced service provider in a circular construction industry. The product follows earlier definitions of what should be on offer in the construction industry (introduced in section 4.1) and is explained below:

*The supply side needs to offer a performance that is supported by a service that optimizes said performance. The performance is based upon a delivered product (i.e. the building). The building is in part a collection of products that are interrelated at different scale levels. These products are delivered by the service provider, usually in combination with (different) supplying parties, but the service provider manages the overall performance.*
Note that the above product definition is a compound of the earlier introduced definition of a performance and a product. With addition of the identification of the possible supplying parties, in this case either the service provider, or a combination of different supplying parties under the management of the service provider.

The way in which the service provider provides the product
After identifying what kind of product needs to be offered in a circular construction industry, this section will now focus on the manner in which the advanced service provider needs to offer said product. It will do so by first introducing the requirements surrounding the role of the advanced service provider and secondly by introducing the business operations the advanced service provider needs to take on (from this point forwards, the term ‘service provider’ will refer to the above described ‘advanced service provider’).

This section will introduce the requirements that follow from earlier sections of this research. These requirements serve a similar role to the requirements noted under the definition of the circular economy, they provide preconditions in order to make the role of the service provider work and therefore offer some grounding. Some of these requirements bear a resemblance to performance-based building, however despite of these similarities the concepts are different from each other. How these two concepts relate to each other can be found in appendix E. The different requirements needed for the service provider to function effectively are:

- **Behaviour of both client and supplier needs to change**
  For the circular economy to work both the behaviour of the client and the supplier needs to change. Clients should start demanding performances that suppliers need to offer. It is needless to say that this requirement has to be in place in order for the service provider to be able to function effectively. This requirement follows from chapters three, five, and was also found in research done by De Grauw (2015), and Jonker (2015).

- **Performance should not be to specified by the client**
  If the client specifies their performance needs in a too detailed fashion, the ability and/or possibilities of the supplying parties to deliver this performance is limited. This decreases the attractiveness for supplying parties to offer such a performance. If the supplier has got no choice in how to offer this performance it will lose the ability to engineer it in such a way that it is still valuable to the supplier after take-back. This requirement follows from chapter five and was also found in research done by Loppies (2015), and Sexton and Barret (2005).

- **A tighter organization on the supply side’s part**
  Working together in a circular construction industry will be more complex for the involved supplying parties when compared to contemporary construction projects. Therefore there needs to be a tighter organization on the supply side’s part in a circular construction industry as the need to work together will increase. This requirement follows from chapters three, five, and was also found in research done by Bastein et al. (2013), and Geldermans and Rosen Jacobson (2015).

- **Decoupling points need to be incorporated in the used products**
  This requirement follows circular economy theory and considers the argument that, if suppliers should be able to take back their products at the end of the building lifetime, they should be able to do so without damaging these products. Therefore
the used products should make use of so-called ‘decoupling points’ that connect the
different products that make up a building together. These decoupling points should
be placed in such a way that one supplier is able to take his products out of the
building without damaging another suppliers’ products (also see ‘different lifetimes’). The way in which these decoupling points are arranged, designed, or
implemented depends upon the preferences of the involved suppliers, as this is
mostly a design decision that involves their own products. This decision is therefore
also an entrepreneurial decision. Although the technical implications of the circular
economy on the construction industry are not the focal point of this research,
without adding this requirement it would be unable for the service provider to
deliver a building that meets the required performances. This requirement was also
found in research done by Geldermans and Rosen Jacobson (2015).

- **Willingness, trust, and transparency are needed**
  Under this tighter organization between the different supplying parties willingness,
  trust and transparency become more important. Through chapter three it became
  clear that this is already an important topic in the construction industry and under
  the influence of the circular economy it will become even more important. This
  requirement was also found in chapter five, and research done by Bastl et al. (2012)
  and Loppies (2015).

After the description of the requirements, this section will now elaborate upon the business
operations the service provider has to perform in order to be of added value in a circular
construction process. The operations of the service provider follow from earlier sections of
this research, and are:

- **The service provider is responsible for the longer term and the different lifetimes**
  With the large amount of different supplying parties in the construction industry and
  their own different time-scopes it seems logical that the service provider would be
  responsible for bundling these time-scopes and guarding these. Several building
  products might have different lifetimes as well, the service provider would need to
  ensure appropriate solutions to this aspect (also see ‘decoupling points’).

- **The service provider is responsible for the lease with client**
  By being responsible for the lease with the client, the service provider could act like
  the ‘missing’ focal firm in the construction industry. Being responsible for the lease
  should attune the different supplying parties towards the service provider (Windahl
  & Lakemond, 2006).

- **The service provider needs to deal with the specific characteristics of the construction
  industry**
  Characteristics like system-based trust and the lack of a focal company can be seen
  as typical for the construction industry. The service provider will need to deal with
  this and provide the required willingness, trust, and transparency as much as
  possible, this in order to avoid too much reliance on judicial governance (as was
  identified in chapter five).

- **The service provider is responsible for picking the products / services**
  The service provider is responsible for picking those products (if needed from
  upstream suppliers) to make up a building that allows for the agreed upon
  performance(s) to be met. This operation follows from chapter five.
• **The service provider needs to determine the building lifetime**
  The building will need to perform at an agreed upon level (established in agreement with the client), but at a certain point it will become impossible to reach the agreed upon level of performance with the products and services that are present in the building. This entails that the products that are responsible for delivering the services that reach the agreed upon performance need to be taken out of the building, effectively ending the building’s lifetime. Therefore the building lifetime needs to be determined before realizing it, whereby the maximum lifetime should be as long as it is possible to deliver the agreed upon performance with the underlying products and services (any lifetime shorter than the technical maximum is however more likely as the lifetime is principally determined by the demands of, and in agreement with the client). This responsibility was also found in research done by Geldermans and Rosen Jacobson (2015).

• **The service provider is responsible for checking the decoupling points**
  This responsibility follows from the requirement that decoupling points need to be present with the products that are used to deliver the agreed upon performance. As it is the service provider that manages the overall performance, it is his responsibility to verify whether the incorporated products can actually deliver upon this requirement.

*The lessons learnt about the service provider*

With the information from this and previous paragraphs it is now clear that the service provider needs to adhere to the following points:

• **The service provider is responsible for the longer term**
• **The service provider is responsible for the lease with client**
• **The service provider needs to deal with the specific characteristics of the construction industry**
• **The service provider is responsible for picking the products**
• **The service provider needs to determine the building lifetime upfront**
• **The service provider is responsible for checking the decoupling points**
• **The service provider needs to offer ‘capabilities’**
• **The service provider needs to re-evaluate its relationships with suppliers**
  o **The service provider needs to consider different roles for existing parties (e.g. with financiers)**
  o **The service provider might need to stretch its organization in order to be able to deliver the agreed upon performance**

6.2 Designing a business model for the service provider

This section will elaborate upon the reason why the sustainable business model framework is used. Because of the way they are set-up the different variants will, besides presenting readers with clear business model prototypes, also be able to be used in a business plan (as laid out by for instance Osterwalder & Pigneur, 2010), while at the same time they could also be used as scenarios to form the basis for scenario planning as laid out by Lindgren and Bandhold (2003).

*The kind of business model framework used in this research*

This section will explain what business model framework will be used in this research and why. Nowadays there are different frameworks that can be used to design business models,
but not all of them might be appropriate to be used in this research. These different frameworks have been developed as public interest in business models has grown significantly over the last 10 years. Before that period business models mostly dealt with acquiring goods for the lowest price possible and subsequently selling those goods with as high an as possible margin. This has changed under the influence of mainly web-based companies that operate in different ways as opposed to this traditional model (Jonker, 2015).

A widely used business model framework that is being used in practice is that of Osterwalder & Pigneur (2010), who created the so-called business model canvas. Given that this model is widely used, and thus recognizable for large numbers of readers, it could be logical to use this canvas to set-up the business model prototypes in this research too. However, the business model canvas (along with other existing frameworks) shows to have little use for innovative and in particular sustainable business models (Bocken et al., 2014).

If a look is given to the definition of innovation, it becomes clear that the business model prototypes developed in this research are of an innovative nature. These business model prototypes usually impact multiple elements of the business model and the attached value chain (Bocken et al., 2014). This impact could be seen as a form of innovation, as innovation can be defined as: ‘the successful launching of new, improved or more competing products, services or organization structures’ (Straub, 2011). Dangelico and Pujari (2010) suggest that for ‘green product’ innovation further distinction can be made between radical product innovation, which features the replacement of a critical component, and incremental product innovation that deals with the improvement of existing components. In this research the definitions of Straub (2011) and Dangelico and Pujari (2010) will be combined in order to be able to categorize the to be developed business models. Therefore the definition given by Dangelico and Pujari (2010) will be altered slightly, instead of merely focusing on a component, the definition in this research will be: ‘radical product innovation features the replacement of a critical component, product, service or organization structure, whereas incremental product innovation deals with the improvement of existing components, products, services, or organization structures.’

In further research Bocken and Short (2015) investigate so-called ‘sufficiency driven’ business models, these are models that aim to curb consumption through various factors such as ‘focusing on needs rather than wants’, an aim that is central to the circular economy concept and radically differs from the underlying logic and mechanisms under tools such as the business model canvas of Osterwalder and Pigneur (2010).

Therefore the business models that will be developed in this research will be sufficiency driven business models that according to Bocken and Short (2015):

‘Aim to curb consumption as part of the business model by moderating demand through education and consumer engagement, making products that last and avoiding built-in obsolescence, extending product lives to slow disposal and replacement, focusing on ‘needs’ rather than promoting ‘wants’ and fast fashion, and reducing overall resource consumption through conscious changes in sales and marketing techniques, new revenue models, and innovative technology solutions.’

Whereby ‘extending product lives to slow disposal and replacement’ is not considered to be part of sufficiency business models in this research, as it follows from chapter two that life extension is not to be considered as a part of the circular economy.
The to be developed business models will be explained through the sustainable business model as presented in Bocken and Short (2015) that was introduced based on earlier research (see figure 22). It followed from Bocken et al. (2014) that the main elements of the business model are made up of the value proposition, that deals with the question what value is provided and to whom, value creation and delivery, that deals with the question how value is provided, and value capture that deals with the question how an organization generates income and captures other forms of value. The different variants presented in this research will all be built up of these three main elements and the underlying eleven sub-elements.

![Figure 22: The sustainable business model framework (Bocken & Short (2015) adapted from Short et al. (2014))](image)

Perhaps surprisingly to some readers, the different variants and the models they contain do not focus on financial specifics in any specific way. While business models frequently (and sometimes for a large part) consist of financial calculations, the choice made in this research is to focus more upon organizational effects of a certain business model. A couple of arguments can be given for this choice:

- First, it was already established in chapter three that the main challenge in implementing the circular economy in the construction industry is to be found at the organizational level. A finding that is confirmed for servitization in other industries through research done by Biege et al. (2012) and Windahl & Lakemond (2006).
- Second, contrary to popular belief and application business models are actually principally not about finances, this is merely the usual form of appearance or focus (Jonker, 2015).
- Thirdly it was found that, through the influence of the circular economy and service provision, more tailored, client-specific solutions are likely to occur. Therefore a financial model would also have to be focused on a quite specific case. Apart from the fact that such a case does not yet exist in the construction industry, the goal of these business model prototypes is to develop a tool that is useful for all of the supplying parties in the construction industry. The addition of a financial model would narrow the focus of these models to specific cases. This would diminish the overall applicability of the prototypes, along this line of reasoning it can also be said that making these models more general would render them less useful.

It does however go without saying that the financial aspect of these variants is of major importance to any company that attempts to use them as a tool (Tukker, 2004). For these parties however, it should be relatively simple to couple their own (financial) situation to the different variants. In this way the addition of a financial model would make the prototypes
6.3 The business model prototypes

This section elaborates upon the business model of the service provider, it will do so by importing the lessons learnt in the preceding parts of this research into different variants. It is chosen to create different variants as the lessons learnt do not point towards one single way in which the service provider can perform its business. First a description of the general business model prototype is presented, following the framework that was developed by Bocken and Short (2015). The largest part of this framework is valid for all of the developed variants. However, elements 7, 9, and 10 of this prototype differ between the variants. As said these variants are based upon knowledge that was gained earlier in this research, and need to deal with the specific context that the construction industry provides for the service provider. In order to make this possible, the variants are built up on three variables (see figure 23):

- The first variable deals with the competences that are present within the organization of the service provider (as it follows from chapter five that a service provider should only pursue the offering of services in those areas that are part of its core business).
- The second variable is the earlier described organizational stretch.
- The third variable is the relationship with suppliers.

Figure 23: Underlying aspects and variables beneath the different variants of the business model prototypes (source: own image)

The last two aspects serve as variables that are chosen because they appear to be the most relevant to the construction industry, as it followed from section 3.2 that the supply side of the construction industry is highly fragmented and that traditional ways of cooperation...
between the different supplying parties persist (these variables are as such a way of dealing with the complexity of the construction industry as introduced in section 6.1). It is important to keep in mind that these aspects only influence certain elements of the business model prototypes (elements 7, 9, & 10), therefore the largest part of the business model prototype will be the same for all of the different variants (see figure 24).

Therefore the first part of this section will introduce this general part of the business model prototype, following the framework as it was laid out by Bocken and Short (2015). The elements that are different for each variant (7, 9, & 10) will be presented for each variant individually after the description of the general part of the prototype. For an overview of the complete business model prototype including those elements that differ between the different variants, the reader is referred to figure 24.

Value proposition
Under the building block ‘value proposition’, three different topics are relevant; product/service, customer segments and relationships, and the value for customer society and environment. These different topics are the same for all the different variants and will be explained below.

1. Product / service
   The service provider delivers housing for the client that is completely tailored to the client’s specific needs. The service provider also makes sure that these needs are met at a certain performance level throughout an upfront determined period of time (also see the definition of the product on offer in section 6.1).

2. Customer segments and relationships
   The service provider is faced with a broad segment of clients looking for a specific performance. The relationship with the client is provider-specific, however since the service provider offers a tailored service it is important that the client is in close contact with the service provider.

3. Value for customer, society, and environment
   The customer receives completely tailored housing, the value for society and environment can be found in the fact that this housing is delivered in a sustainable manner.

Value creation and delivery
The next building block of the framework of Bocken et al. (2015) is referred to as value creation and delivery. Five different topics are relevant here; activities, resources, distribution channels, partners and suppliers, and technology and product features. These topics will be explained below. The topic ‘partners and suppliers’ (aspect number 7 in figure 24) is influenced by the three earlier introduced variables and has therefore got five different variants.

4. Activities
   The service provider performs either all of the following activities: designing, building, financing, maintaining, and operating, or (more likely) it performs one or more of these
**Value Proposition**

1. **Product / service**
   Housing that is completely tailored to the needs of the customer, at a certain performance, for a given time-period

2. **Customer segments and relationships**
   Broad segment with specific clients looking for a specific performance

3. **Value for customer, society, and environment**
   The customer receives tailored housing, society and the environment receive this in a sustainable manner

---

**Value creation & delivery**

4. **Activities**
   The service provider performs one, some, or all of the following: designing, building, financing, maintaining, operating

5. **Resources**
   The inherent knowledge the service provider has about the activities it performs

6. **Distribution channels**
   Can differ between service providers

7. **Partners and suppliers**

8. **Technology and product features**
   Non-toxic, pure materials of which the origins are known, supported by renewable energy. Also flexible, but the amount thereof is dependent upon the chosen model under point 7.

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**Value Capture**

9. **Cost structure and revenue streams**

10. **Value capture for key actors (incl. environment and society)**

11. **Growth strategy / ethos**
    Can differ between service providers

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*Financing as an activity always needs to be coupled with one of the other activities, in this model it cannot be the service provider’s only competence.

---

**Figure 24:** The five different business model prototypes with both the common and different aspects in the sustainable business model framework (source: own image, framework by Bocken & Short (2015))
Activities. If the service provider performs financing, this is always in combination with one of the other activities as the product or (performance) on offer is supported by an underlying (physical) product (see the definition in section 6.1).

5. Resources
The service providers’ resource is the inherent knowledge it has about the activities it performs. This knowledge enables the service provider to deliver the agreed upon performance in an efficient way.

6. Distribution channels
The distribution channels are service-provider specific and will thus differ for each provider. This topic is therefore not worked out in more detail in the business model prototypes that are under development here.

7. Partners and suppliers
The relevant partners and suppliers can differ depending upon the chosen model. However the partners will always entail one or more of the following: the client, external suppliers and/or financiers. The client is a key partner because the product on offer here is housing that is completely tailored to the client’s needs, therefore the involvement of the client in this process is inevitable. The choice of the service provider to engage in an organizational stretch and/or lease-solutions with possible suppliers determines the model that is chosen. Topic number 7, along with the other variant-specific topics (9 and 10) will be elaborated upon later on in this section.

8. Technology and product features
With regard to the product it can be said that it will be made-up of non-toxic, pure materials of which the origins are known. Furthermore the product will be flexible, but the degree of which is dependent upon the choice made under 7.

Value capture
The third building block of the business model framework deals with value capturing. Three different topics are introduced here; cost structure and revenue streams, value capture for key actors, and growth strategy or ethos. These first two topics (topic numbers 8 and 9 in figure 24) are influenced by the three earlier introduced variables and have therefore got five different variants.

9. Cost structure and revenue streams
The exact structure and streams are dependent upon the choice made under 7, therefore topic number 9, along with the other variant-specific topics (7 and 10) will be elaborated upon later on in this section.

10. Value capture for key actors including society and environment
The exact structure and streams are dependent upon the choice made under 7, therefore topic number 10, along with the other variant-specific topics (7 and 9) will be elaborated upon later on in this section.

11. Growth strategy / ethos
The distribution channels are provider-specific and will thus differ for each provider. This topic is therefore not worked out in more detail in the business model prototypes that are under development here.
The different variants
This section will give a more detailed look at the five different variants of the business model prototypes. Therefore this section will focus only on those topics of the business model framework that are different for the five variants; partners and suppliers, cost structure and revenue streams, and value capture for key actors (topic numbers 7, 9, and 10 in figure 24).

Variant 1

![Organizational model of variant 1](source: own image)

7. Partners and suppliers
Within variant 1 the service provider does not make an organizational stretch that is as large as needed in order to deliver the agreed upon performance in such an efficient way as possible. The service provider does also not enter into lease-solutions with other supplying parties. This can happen when the service provider’s stretch reaches thus far that it does not need any other supplying parties to deliver the agreed upon performance. Or in other words the agreed upon performance is part of its core business completely, and the service provider has got all of the necessary competences within the own organization. Therefore the organization as depicted in figure 25, without any external suppliers suffices for the delivery of the agreed upon performance in variant 1.

9. Cost structure and revenue streams
Figure 26 depicts the economic model behind variant 1, the model clearly shows the implications of the lease-solution between the service provider and the client. Dependent upon whether the service provider has got the financial means to offer the agreed upon performance, the financier is also part of this model. The financier comes into play when the service provider does not have sufficient financial means to offer the agreed upon performance by itself and acts according to figure 25. When the financier is part of the organizational model, the destination of the periodic asset payment changes. Furthermore, the service provider would enter into a finance lease with the financier. Therefore additional agreements between these parties are needed to make sure that at the end of lifetime the service provider remains the owner of the resources (because of the earlier described incentive shift).

10. Value capture for key actors
Below the different values for the key actors are described:

- User
The user receives housing that is completely tailored to his/her needs. The service provider also makes sure that these needs are met at a certain performance level
throughout an upfront determined period of time (also see the definition of the product on offer in section 6.1).

- **Service provider**
  The service provider receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the service provider remains ownership over its deployed products and materials, providing resource security. If the organization of the service provider is arranged effectively and consistent to variant 1, scale benefits might appear for the service provider as the same organization might be able to perform in multiple projects (unlike current construction industry practices).

- **Financier**
  The financier would perform its task in a similar way as is customary today, the only difference is that the transactions with regards to the payments may come from different (than usual) parties.

- **Society & environment**
  Society and environment will receive housing that is fit for its purpose and is realized in a sustainable manner (also see business model aspect number 3).

*Figure 26: economic model of variant 1 (source: own image)*
7. **Partners and suppliers**

Within this variant the service provider makes an organizational stretch that is as large as needed in order to deliver the agreed upon performance in such an efficient way as possible. The service provider does also enter into lease-solutions with other supplying parties. This can happen when the service provider’s stretch does not reach thus far that it does not need any other supplying parties to deliver the agreed upon performance. In other words the agreed upon performance is not completely part of its core business (after acquisition of suppliers 1 and 2), and the service provider does not have all of the necessary competences within the own organization. Therefore the organization as depicted in figure 27 does not suffice for the delivery of the agreed upon performance, additional suppliers are needed (suppliers 3-n).

9. **Cost structure and revenue streams**

Figure 28 depicts the economic model behind variant two. It clearly shows the implications of the lease-solution between the service provider and the client. Dependent upon whether the service provider has got the financial means to offer the agreed upon performance, the financier is also part of this model. The financier comes into play when the service provider does not have sufficient financial means to offer the agreed upon performance by itself and acts according to figure 28. When the financier is implemented, the destination of the periodic asset payment changes. Furthermore, the service provider would enter into a finance lease with the financier. Therefore additional agreements between these parties are needed to make sure that at the end of lifetime the service provider remains the owner of the resources (because of the earlier described incentive shift). A similar kind of agreement as the one between the service provider and the client, is entered between the service provider and those suppliers that are not part of the service provider’s organization.

As the external suppliers are also connected to the service provider with a lease, the supplier also receives a periodic asset payment for the delivery of its product (see figure 28), and a periodic service payment for delivered services. Maintenance and/or management-services that are provided by the external suppliers could either be delivered straight to the client or through the service provider, depending upon the arrangements made between the service provider and external supplier in question. A financier could also be implemented in between the service provider and the supplier, this would work in the same way as described above for the situation between the user and the service provider. Please note however that in order to enhance the probability of this second finance lease to occur, it might be necessary for the supplier to already know the final application (its role in the end-client’s value proposition). Since it is this application that determines the likeliness of payment for the financier.
10. Value capture for key actors
Below the different values for the key actors are described:

• User
The user receives housing that is completely tailored to his/her needs. The service provider also makes sure that these needs are met at a certain performance level throughout an upfront determined period of time (also see the definition of the product on offer in section 6.1).

• Service provider
The service provider receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the service provider remains ownership over its deployed products and materials, providing resource security over those deployed products. If the organization of the service provider is arranged effectively and consistent to variant two, some scale benefits might appear for the service provider as the same core-organization might be able to perform in multiple projects.

• External supplier(s)
The external supplier receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the external supplier remains ownership over its deployed products and materials, providing resource security over those deployed products.

• Financier
The financier would perform its task in a similar way as is customary today, the only difference is that the transactions with regards to the payments may come from different (than usual) parties.

• Society & environment
Society and environment will receive housing that is fit for its purpose and is realized in a sustainable manner (also see business model aspect number 3).
Figure 28: Economic model of variant 2 (source: own image)
Variant 3

![Organizational model of variant 3](source: own image)

7. Partners and suppliers

Within variant 3 the service provider does not make an organizational stretch, but does enter into lease-solutions with other supplying parties. This situation might occur when the service provider does already have a lot (but not all) of the needed skills to deliver the agreed upon performance within its own organization. It could also be that the service provider wants to opt for a different risk profile, in shifting the sorts of payments that need to be made over time. Figure 29 describes this situation, it is worth noting that there is not a limited amount of possible suppliers in this situation, it might be the case that additional suppliers are needed.

Variant 3 could also entail different suppliers coming together and acting as a singular service provider. This might be the case when neither of the supplying parties wants to be fully responsible for the project or does not want to serve as a supplying party within the organization of the service provider. In this way, variant 3 comes close to consortium-contracts that are already implemented in some projects in the construction industry (like DBFMO contracts). However these are not exactly the same as variant 3 clearly needs to be circular and these consortium-contracts are, as of yet, not circular. Besides, these consortium-contracts do also not include lease solutions yet (see section 4.2).

9. Cost structure and revenue streams

Figure 30 depicts the economic model behind variant three. It clearly shows the implications of the lease-solution between the service provider and the client. Dependent upon whether the service provider has got the financial means to offer the agreed upon performance, the financier is also part of this model. The financier comes into play when the service provider does not have sufficient financial means to offer the agreed upon performance by itself and acts according to figure 30. When the financier is part of the organizational model, the destination of the periodic asset payment changes. Furthermore, the service provider would enter into a financial lease with the financier. Therefore additional agreements between these parties are needed to make sure that at the end of lifetime the service provider remains the owner of the resources (because of the earlier described incentive shift). A similar kind of agreement as the one between the service provider and the client, is entered between the service provider and those suppliers that are not part of the service provider’s organization.

As the external suppliers are also connected to the service provider with a lease, the supplier also receives a periodic asset payment for the delivery of its product (see figure 30), and a periodic service payment for delivered services. Maintenance and/or management-services that are provided by the external suppliers could either be delivered straight to the user or through the service provider.
client or through the service provider, depending upon the arrangements made between the service provider and external supplier in question. A financier could also be implemented in between the service provider and the supplier, this would work in the same way as described above for the situation between the user and the service provider. Please note however that in order to enhance the probability of this second finance lease to occur, it might be necessary for the supplier to already know the final application (its role in the end-client’s value proposition). Since it is this application that determines the likeliness of payment for the financier.

10. Value capture for key actors
Below the different values for the key actors are described:

- **User**
The user receives housing that is completely tailored to his/her needs. The service provider also makes sure that these needs are met at a certain performance level throughout an upfront determined period of time (also see the definition of the product on offer in section 6.1).

- **Service provider**
The service provider receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the service provider remains ownership over its deployed products and materials, providing resource security over those deployed products. In this variant scale benefits are not likely to occur due to the need to rely on external suppliers. This will make the committed organization in principle only committed to the particular project that the particular organization is responsible for.

- **External supplier(s)**
The external supplier receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the external supplier remains ownership over its deployed products and materials, providing resource security over those deployed products.

- **Financier**
The financier would perform its task in a similar way as is customary today, the only difference is that the transactions with regards to the payments may come from different (than usual) parties.

- **Society & environment**
Society and environment will receive housing that is fit for its purpose and is realized in a sustainable manner (also see business model aspect number 3).
Figure 30. Economic model of variant 3 (source: own image)
7. Partners and suppliers
Within variant 4 the service provider makes an organizational stretch that is as large as needed in order to deliver the agreed upon performance in such an efficient way as possible. The service provider does however not enter into lease-solutions with other supplying parties. However, the agreed upon performance is not completely a part of its core business (even after acquisition of suppliers 1-2), and the service provider does not have all of the necessary competences within the own organization. This can happen when a further stretch would not make the delivery of the agreed upon performance any more efficient then without this further stretch. Suppliers 3-n are thus a part of variant 4 as the organizational stretch is not large enough to deliver the agreed upon performance without these parties. Therefore the organization as depicted in figure 31, with suppliers 3-n, suffices for the delivery of the agreed upon performance in variant 4.

9. Cost structure and revenue streams
Variant 4’s model changes some streams to the economic model of variant 1 with the introduction of additional external suppliers (figure 32). It clearly shows the implications of the lease-solution between the service provider and the client. Dependent upon whether the service provider has got the financial means to offer the agreed upon performance, the financier is also part of this model. The financier comes into play when the service provider does not have sufficient financial means to offer the agreed upon performance by itself and acts according to figure 32. When the financier is part of the organizational model, the destination of the periodic asset payment changes. Furthermore, the service provider would enter into a finance lease with the financier. Therefore additional agreements between these parties are needed to make sure that at the end of lifetime the service provider remains the owner of the resources (because of the earlier described incentive shift).

As the external suppliers are not connected to the service provider with a lease, the supplier merely receives a lump sum for the delivery of its product (see figure 32). In the case of delivery of intermediate services, the supplier does however receive periodic service payments from the service provider and is engaged in possible penalties and / or compensation payments in exchange for these intermediate services. If the external supplier only delivers basic services, these payments will not be included in the economic model as the supplier will not engage in maintenance and/or management services of its product.
10. Value capture for key actors

Below the different values for the key actors are described:

• **User**
  The user receives housing that is completely tailored to his/her needs. The service provider also makes sure that these needs are met at a certain performance level throughout an upfront determined period of time (also see the definition of the product on offer in section 6.1).

• **Service provider**
  The service provider receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the service provider remains ownership over its deployed products and materials, providing resource security over those deployed products. In this variant scale benefits are not likely to occur due to the need to rely on external suppliers. This will make the committed organization in principle only committed to the particular project that the particular organization is responsible for.

• **External supplier(s)**
  The external supplier receives a lump sum for the delivery of its product. The supplier does not receive any periodical payments, unless intermediate services are delivered to the project. Furthermore the external supplier does not maintain ownership over its deployed products and materials, and had therefore no resource security over those deployed products.

• **Financier**
  The financier would perform its task in a similar way as is customary today, the only difference is that the transactions with regards to the payments may come from different (than usual) parties.

• **Society & environment**
  Society and environment will receive housing that is fit for its purpose and is realized in a sustainable manner (also see business model aspect number 3).
Figure 32: Economic model of variant 4 (source: own image)
Variant 5

![Organizational model of variant 5](source: own image)

7. **Partners and suppliers**
With variant 5 the service provider does not make an organizational stretch, and also does not enter into lease-solutions with other supplying parties. This situation might occur when the service provider does already have a lot of the needed skills (but not all!) to deliver the agreed upon performance within in its own organization. It could also be that the service provider wants to opt for a different risk profile, in shifting the sorts of payments that need to be made over time. Figure 33 describes this situation, it is worth noting that there is not a limited amount of possible suppliers in this situation, it might be the case that additional suppliers (1-n) are needed.

Variant 5 could also entail different suppliers coming together and acting as a singular service provider (similar to variant 3). This might be the case when neither of the supplying parties wants to be fully responsible for the project or does not want to serve as a supplying party within the organization of the service provider.

9. **Cost structure and revenue streams**
Figure 34 depicts the economic model behind variant five. It clearly shows the implications of the lease-solution between the service provider and the client. Dependent upon whether the service provider has got the financial means to offer the agreed upon performance, the financier is also part of this model. The financier comes into play when the service provider does not have sufficient financial means to offer the agreed upon performance by itself and acts according to figure 34. When the financier is part of the organizational model, the destination of the periodic asset payment changes. Furthermore, the service provider would enter into a finance lease with the financier. Therefore additional agreements between these parties are needed to make sure that at the end of lifetime the service provider remains the owner of the resources (because of the earlier described incentive shift).

As the external suppliers are not connected to the service provider with a lease, the supplier merely receives a lump sum for the delivery of its product (see figure 34). In the case of delivery of intermediate services, the supplier does however receive periodic service payments from the service provider and is engaged in possible penalties and / or compensation payments in exchange for these intermediate services. If the external supplier only delivers base services these payments will not be included in the economic model, as the supplier will not engage in maintenance and/or management services of its product.
10. Value capture for key actors

Below the different values for the key actors are described:

- **User**
  The user receives housing that is completely tailored to his/her needs. The service provider also makes sure that these needs are met at a certain performance level throughout an upfront determined period of time (also see the definition of the product on offer in section 6.1).

- **Service provider**
  The service provider receives a constant income stream from service payments (and asset payments in case the provider does not make use of a secondary financier). Furthermore the service provider remains ownership over its deployed products and materials, providing resource security over those deployed products. In this variant scale benefits are not likely to occur due to the need to rely on external suppliers. This will make the committed organization in principle only committed to the particular project that the particular organization is responsible for.

- **External supplier(s)**
  The external supplier receives a lump sum for the delivery of its product. The supplier does not receive any periodical payments, unless intermediate services are delivered to the project. Furthermore the external supplier does not maintain ownership over its deployed products and materials, and had therefore no resource security over those deployed products.

- **Financier**
  The financier would perform its task in a similar way as is customary today, the only difference is that the transactions with regards to the payments may come from different parties.

- **Society & environment**
  Society and environment will receive housing that is fit for its purpose and is realized in a sustainable manner (also see business model aspect number 3).
Figure 34: Economic model of variant 5 (source: own image)
6.4 The relationship between the business model prototypes and theory
This section will analyse the developed business model prototypes of section 6.3 with earlier theory in this report. In this way it becomes possible to relate the models to circular economy theory, and to see how the models compare with this theory.

Figure 35: The position of the 5 different variants (the numbers in red) in the circular service level framework (as introduced in figure 20).

The position of the different variants in the circular economic context
Figure 35 shows where the different variants of business model prototypes can be placed in relation to the circular economic service levels. Variants 1, 2, and 3 can be seen as directly emerging from circular economic theory as it was introduced and followed in section 3.3 and chapter 4. These different variants place emphasis on the ‘right’ location of the incentive through not only risk-sharing (e.g. lease) solutions with clients, but also with upstream suppliers. Of these variants, number 1 has the clearest incentive as the service provider is solely responsible for delivering the agreed upon performance without any external suppliers. Variant two and three try to secure this incentive through risk-sharing solutions with suppliers as well as with clients, variant 2 adds an organizational stretch to this picture.

Variants 4 and 5 emerge from the findings in chapter 5, where it became clear that under certain circumstances it can be possible to have external suppliers who are not included in a risk-sharing agreement (see figure 19). Although this is a division from the circular economic theory as it was presented in earlier chapters, examples from chapter five show that it is possible to operate in this way as long as the suppliers are monitored and commit themselves to agreed upon standards. In fact this way of operating is present within base to intermediate circular service solutions, the fact that the service provider still engages in risk-sharing solutions with the client however, makes that these solutions are still advanced services solutions.

When a look is given at the different characteristics of the variants in a circular economic context (see table 4), it becomes clear that variant 1 is the variant that probably comes closest to the foregoing theory. This is in accordance with figure 35, however as variant 1 needs a service provider that has got all of the different competences in its organization, it is also the variant that is probably least expected to be found in the short-term in construction industry (if attention is given to the characteristics of the industry as laid out in chapter 3).
<table>
<thead>
<tr>
<th></th>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
<th>Variant 4</th>
<th>Variant 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of external parties</td>
<td>Low</td>
<td>Fairly Low</td>
<td>Medium</td>
<td>Fairly High</td>
<td>High</td>
</tr>
<tr>
<td>Amount of decoupling points</td>
<td>Low</td>
<td>Fairly low</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Dependence upon external parties</td>
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<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Possible scale benefits</td>
<td>High</td>
<td>Fairly high</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 4: Comparison between the characteristics of the five different variants with variant 3 as a baseline (source: own table)

As explained following figure 35, variants two and three are closest to circular economic theory after variant one. From table 4 it follows that there are some differences to be found in their characteristics, these differences stem from the underlying variables. As such, variant two shows good circular potential, but through the organizational stretch that is present in variant two the number of external parties is lower when compared to variant three. As such there are more potential scale benefits for the core-organization. However variant two could entail a very large organizational stretch by the service provider (depending upon how many of the required competences for delivering the agreed upon performance are already present in the service provider’s organization), therefore for some parties this could not be the most probable variant to choose for. For both variants two and three, the dependence upon external suppliers is high, since there is a need to find additional suppliers that are willing to perform in a similar way as the service provider (in order for the financial incentive to be in the correct place). However for variant two the amount of needed decoupling points could be quite low, improving its circular potential (see section 3.3).

The earlier assumption (made following figure 35) that variants four and five are advanced services solutions but less theoretically pure, seems to be confirmed by table 4. The amount of external suppliers ranges from ‘fairly high’ to ‘high’, with a corresponding amount of decoupling points (see section 3.3). The dependence on external supplier is lower when compared to variants 2 and 3 in the sense that these suppliers are not participating in a risk-sharing solution. These parties are however needed for the efficient execution of a project. For variant four, the same remarks about the organizational stretch can be made as under variant two. With these variants, scale benefits are not likely to occur due to the need to rely on external suppliers that are not involved in risk-sharing solutions, and therefore do not need to be as like-minded as the service provider when compared to the other variants. This will make the committed organization in principle only committed to the particular project that the particular organization is responsible for.

The other obstacle that came forward in through the exercises in section 3.3 was the ability to finance a circular construction industry. In the exercise, a look was given towards a contractor that would offer advanced circular services through a lease solution. It could be concluded from that exercise that it would be unsustainable for the contractor to lease the constructed dwellings. Although the service provider studied in these business model prototypes is a new entity, it can still be presumed that similar issues can be expected when
it comes to financing a project. This is one of the consequences for choosing for advanced services, and would (arguably) not appear when choosing for base- to intermediate circular services. However, as explained in section 6.1 both the financial and sustainable benefits are potentially much greater with advanced services solutions, partly justifying the choice to develop these business model prototypes in this research (for the other reasons, see section 6.1). Furthermore, the variants offer a way around directly running into the financial obstacle through the ability of a finance lease with a financier. This can be seen in the economic models that are part of the different variants, where use can be made of a financier in a similar way as in an energy saving company (ESCO) (Zhang et al., 2015). This also explains why finance is not one of the determinants behind the different variables for the variants (see figure 23), and why financial competences should always be combined with one of the other ‘DBMO’ competences (see figure 24). This as the position of the financier in these variants is not comparable to other supplying parties, since the definition of the performance on offer with advanced services is based upon an underlying product. Besides through engaging in ESCO-like arrangements, the financing issues could of course also be circumvented by a service provider that has sufficient capital means by itself.

Notwithstanding these arguments, it can be said that finance issues similar to those that were found in the exercise could still occur. When opting for variant one for instance, one single party would be offering circular services, this leaves less room for risk mitigation. The same can be said for the other variants, except for those versions of variants 3 and 5 where a consortium is formed for the delivery of services. However it can be argued whether it would be any easier for a consortium to finance a lease solution as compared to a situation with one, single party acting as the service provider. Therefore a (theoretically) possible solution to this obstacle has been created, however it remains to be seen how this solution will hold in real life.

**Likeliness of appearance of the different variants**
As already stated above, it is questionable whether variant 1 can be found in the construction-industry any time soon due to the nature of the organization of the service provider. For the other variants this argument is less valid, however all parties do contain risk-sharing solutions with clients that are as of yet unprecedented in the industry. One can also wonder whether an organizational stretch is something that would occur in the near future. Therefore it can be questioned in to what degree the models are readily applicable in the current construction industry.

**Concluding remarks**
This chapter dealt with the design of several business model prototypes for a circular construction industry dealing with (intermediate to) advanced services. In order to be able to do that, the first section elaborated upon the role of the service provider as it was introduced in earlier chapters following the literature on the circular economy and the earlier sections of this research. Therefore first it was determined that the service provider that is under investigation in this research, is the service provider that delivers (intermediate to) advanced services to the client. This is because such a model is as of yet not present in the construction industry, whereas (although incomplete) models for base to intermediate service delivery can already be found in the circular construction industry. Also, when it comes to sustainability and profitability, (intermediate to) advanced services show greater potential. Thereafter the product that the advanced services provider needs to offer was identified as: ‘a performance that is supported by a service that optimizes said performance. The performance is based upon a delivered product (i.e. the building). The building is in part a collection of products that are interrelated at different scale levels. These products are delivered by the service provider, usually in combination with (different) supplying parties,
but the service provider manages the overall performance.’ The third part of this section of focused on the way in which the advanced service provider needs to deliver the product following circular economic literature. It was found that in order for the service provider to function effectively the following requirements need to be in place: the behaviour of both client and supplier need to change, the required performance should not be too specified by the client, there should be a tighter organization on the supply side’s part, willingness, trust and transparency are needed between the involved parties, and finally ‘dearness’ should only play a role if the building is perceived to be of added value. Thereafter some business operations of the advanced services provider were identified, these are responsibilities concerning: the longer term of the building project, the lease with the client, the specific characteristics of the construction industry, picking the products to be used in the building, determination of the lifetime of the building, and responsibility over so-called decoupling points.

The next section of this chapter chose the framework that would fit the business model prototypes. The choice was made to use the sustainable business model framework as presented by Bocken et al. (2015).

The following section presented these business model prototypes. Different variants were developed as a consequence of both the characteristics of the construction industry and earlier findings on circular economy theory and its implications. Therefore the models are based upon whether the service provider has got all of the needed competences in its own organization, followed by the variables lease-solutions and organizational stretch. These variables however only affected three out of eleven aspects of the sustainable model framework, for all of the other aspects, the same framework can be used for all of the developed variants.

The last section compared the developed variants with foregoing theory in the report. It was found that variants one, two, and three are closest to this theory, while variants four and five emerged from findings presented in chapter five. All five variants are however advanced service solutions. Lastly, this section reflected upon the likeliness of appearance of these models in the near future from a theoretical standpoint. It was stated that it can be questioned to what degree the models are readily applicable in the current construction industry.
7. The service provider in practice
*Section 7.3 of this chapter is co-authored and edited by R. Stigter (contact details can be found in appendix A)*

This chapter will examine the role of the service provider in practice. In order to be able to do so several validation interviews with practitioners have been conducted. These interviews were based upon the developed business model prototypes as presented in chapter 6. After presenting the findings of these interviews, this chapter will also present the findings from several case studies as well as findings done by Stigter (2016). Thereafter these different findings will be included in a discussion after which some conclusions are drawn considering the service provider in practice.

7.1 Findings from the validation interviews

This section will present the findings from the validation interviews. These interviews were conducted in order to relate supplying parties from practice to the developed business model prototypes as introduced in chapter 6. Therefore four different parties were interviewed from different sections of the supply-side spectrum. This in order to get a wider view of this supply-side, it is important to add that all four companies are Dutch. One party’s core business entails maintenance provision for housing associations, another party is a medium-sized contractor, whereas the third party is a large-size contractor, and the fourth is a large sized contractor/developer. Of these four parties, the large contractor/developer has got actual experience in a basic- to intermediate circular services project (Appendix M). The other larger contractor has been busy trying to implement circular economy into its construction-process waste stream. Both the medium-sized contractor and the maintenance provider have got no practical experience with the circular economy (but are familiar with the concept). It is however important to note that each actor has recently been busy realising either a sustainable or circular project that will be analysed in section 7.2 (Appendices J-M). When asked whether the circular economy could be seen as a potential business opportunity, all parties replied that this is, or could indeed be, the case.

Response to the business model prototypes

From section 6.2 it followed that the key resources of the advanced service provider lie in the inherent knowledge of its key activities, or in other words its competences. Therefore the respondents were asked which competences were present in their own organization. This is because if all competences (designing, building, maintaining, operating) were to be present in the organization of the respondent, they would be able to act as a service provider without the need to work with any external supplier. This turned out not to be the case for any of the respondents as they nearly always rely on external suppliers for at least part of a project. Three out of four interviewees did however expect that their activities would change if they would participate in the delivery of advanced services. One respondent thought that this change could occur as a consequence of external changes to the market (e.g. a company like IKEA developing turn-key housing) whereas two respondents expected this change to come from within the building industry itself.

On the question whether the interviewees would engage in an organizational stretch in order to be able to deliver the agreed upon performance, three out of four responded that this is unlikely to happen in the near future. On the long-term however, under the influence of both the circular economy and market demand, two out of four respondents saw this as a possibility. All four respondents pointed out that market demand is crucial for them in order to implement the circular economy in the first place. As already stated above, one of the interviewees has already done a basic- to intermediate circular services project and has thus
experienced market demand. Two other respondents are expecting a demand from the market in the foreseeable future.

Respondents saw it as more likely that they would engage in lease-solutions with their suppliers. As stated above, the interviewees acknowledged the fact that they need external suppliers in their projects. Often, the respondents use the same suppliers in multiple projects, which they refer to as their ‘chain-partners’ or ‘co-makers’. With these parties it is seen as likely to engage into lease-solutions. However, the interviewees do not take this step lightly as they acknowledge that a lot of agreements between different parties have to be made in order for this to work and to make sure that suppliers will follow the company in their chosen strategy. Two out of four interviewees state that they could imagine these suppliers remaining owner of their own committed resource. It was also stated by two respondents that these more complex engagements are unlikely to be realized with one-off suppliers.

Just as with entering into an organizational stretch, the respondents see it as unlikely that they would enter into lease-solutions (with clients) in the near future. Two interviewees think that supply side companies in the building industry will need time for ‘this change in thinking’, with one respondent adding that they feel that in recent years the construction industry has already witnessed a large turnaround in market-approach by the supplying parties.

Each respondent does however see chances for the re-design of products under influence of the circular economy, especially in the light of ‘closing the loops’. Although there are some points of attention regarding this subject; re-design raises the question what underlying value a product will have, especially considering legislation (more on both of these points later on). Furthermore all respondents state that larger portions of their work are nowadays devoted to renovation projects where products have not been re-designed beforehand and their exchangeability is more dependent upon luck than on a conscious strategy. Finally, all respondents see opportunities to offer installations in a building (e.g. heating and cooling) through lease-constructions (with possibly an external supplier remaining owner of the installations) and to re-design these installations as such that they would be compliant with this way of offering. This indicates that some building components might be easier to offer through lease-constructions than others (not forgetting possible legal issues).

It also became clear that the interviewed parties do not see a problem in being committed to a project for a longer period of time. In fact, three out of four interviewees indicated that they are already involved in contracts that tie them to projects for longer periods of time. They do however acknowledge the fact that a longer period brings more uncertainty, therefore one of the respondents indicates that they prefer to engage in more long-term commitment with (semi-)governmental parties instead of commercial parties. But this uncertainty is not only related to the value of a product at the end of a loop and legislation, but also to the lack of knowledge about materials and products used in a project. Since three out of four respondents indicate that there is usually little knowledge on this issue in their projects, this while the interviewees do indicate that knowledge about materials is essential in being able to make decisions from a circular economic point of view (about for instance the materials to be used, the required maintenance, and what to do at the end-of-loop situation). This might be linked to the role the interviewees see for their organization in the building industry, which three out of four respondents describe as the ‘coordinator’ or ‘assembler’ of the building process. One respondent elaborates and states that there will also be little knowledge on this topic to be found with clients and external suppliers. Two
out of four respondents also indicate that knowledge about disassembly (which is related to an end-of-loop situation) is not present within their organizations, as this has never been part of their projects. Two respondents are however underway in developing a resource passport for buildings, in an effort to enhance their knowledge of the materials and products used in a project.

When concerning both re-design and long-term commitment, the (financial) value of a product at the end-of-loop situation has been mentioned. This can be seen as a big question that is experienced by the interviewees. The supplying parties do, as of yet, not know what the value of a product will be at the end-of-loop situation. One of the respondents states that he expects resource prices to rise in the long-term and sees it as a possible solution to this uncertainty. However three out of four interviewees state that the value at the end-of-loop situation will also be determined by the ease with which their products will be able to be deployed in other projects (even if they would be re-designed). This raises the question for the respondents as to how this uncertainty will be incorporated into the product-price. And if in return for taking on more risk on the supply-side’s part, products offered through advanced services will not be more expensive than ‘traditional’ products due to this risk-premium.

Along with the value of a product at an end-of-loop situation, legislation has been mentioned in previous subjects. The two respondents that have the most experience within the circular economic field indicate that legislation is a cause of the aforementioned uncertainty. This is because legislation, in this case mostly building regulations, tends to be progressive in nature (e.g. the required insulation value of a home). This makes it more difficult to redeplo y products (without alterations) after a certain period of time. The interviewee that was involved in a basic- to intermediate circular services project stated that their project would miss-out on possible subsidies if they would have offered advanced services (such as lease-solutions), and that partly therefore the client opted for basic- to intermediate services instead. This leads to a situation where, under the influence of changing legislation, it is not certain whether products can be redeployed. Or as one of the respondents put it:

‘The lower you can move backwards in the product chain (back towards resources), the more flexible you are, thus the higher the chance of resource preservation’

In general, the interviews made clear that currently some developments are taking place in the (Dutch) construction industry. Three out of four parties indicate that they are nowadays more focused on the needs of the client, this comes to show in the more complex contracts with wider responsibilities that are now becoming more customary in the construction industry. One of the interviewees stated that his organization actually prefers these more complex contracts as they offer a better chance of displaying unique selling points as opposed to ‘traditional’ contracts. Although it does need to be noted here that two respondents indicate that, at least for their clients, steering on (financial) costs is still the most important instrument. Two interviewees therefore indicate that if a client does not want to participate in an advanced services project, they will not offer these advanced services. It also became clear that for the prototypes to be able to become effective, further development or innovation is needed when it comes to financing projects and ensuring that products stay in the loops (also see appendices J-M).

In the end, three out of four respondents ended up with either variant 3 or 5. Under the preconditions and remarks that were presented in this section, the interviewees saw these
prototypes as probable future business models. One of the respondents also thought of variant 2 as a probable future business model, under the same restrictions as for the other variants. One interviewee could not relate itself to any of the prototypes yet, as he was more convinced of base- to intermediate circular solutions. This interviewee elaborated that if advanced-services models would prove to be fruitful, his company would naturally pursue these solutions as well. It is therefore hard to tell whether this interviewee would perform as a service provider or a supplier in the developed business model prototypes. Of the other respondents, two contractors would see themselves as service providers in the developed variants. The maintenance provider for the housing association viewed its own role as that of a supplier in light of the developed business model prototypes.

7.2 Findings from the case studies
As mentioned before in section 7.1 the validation interviews revealed several sustainable projects that were undertaken by the companies of the interviewees. This section will present the findings that were done in the subsequent case studies of those sustainable projects. All relevant information for this section has been taken from appendices J-M (more detailed information can be found in those appendices).

Of the four studied projects only the Alliander case has been carried-out from a circular perspective. The Iewan case has been made according to a cradle-to-cradle perspective and the other two cases have not been realized through any sustainable theory, although the Growing Green case does show some sustainable choices throughout the project.

<table>
<thead>
<tr>
<th></th>
<th>Iewan</th>
<th>Growing Green</th>
<th>Alliander</th>
<th>Heijmans One</th>
</tr>
</thead>
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<td>Renovation</td>
<td>Renovation</td>
<td>New-built</td>
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<td>Partly conscious</td>
<td>Conscious</td>
<td>Not conscious</td>
</tr>
<tr>
<td>Re-/disassembly</td>
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<td>No</td>
<td>Partly Yes</td>
<td>(Partly) Yes</td>
</tr>
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<td>Consortium</td>
<td>Consortium</td>
<td>Sole operator (incl. architect)</td>
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<td>organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>None</td>
<td>Judicial</td>
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</tr>
<tr>
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<td>Base- to intermediate</td>
<td>Base- to intermediate</td>
<td>Base- to intermediate</td>
<td>Advanced</td>
</tr>
</tbody>
</table>

Table 5: Overview of the project characteristics of the case studies (own table)

When a look is given to table 5 it becomes clear that two of the projects are new-built and two are focused upon renovation. Through the fact that both the Alliander and Iewan project have been realized through the lens of sustainable concept, they both show conscious material choices throughout the project. The Growing Green project has not been realized through a sustainable concept and instead aims for energy reduction and higher real estate value for owners. Interestingly though some conscious material choices have been made in this project, without any clear incentive present. The Heijmans One project on the other hand shows no apparent conscious material choices at all.

When it comes to the ability for re- or disassembly it becomes clear that most projects lack the ability to do so on a project level (see table 5). Growing Green is essentially a re-assembly project and therefore it is interesting to see that no apparent attention has been given to a possible disassembly-stage of the project. Some parts of the Alliander project have been constructed in such a way that they can be deconstructed again (but not
throughout the project as a whole). Also the Heijmans One can be disassembled into its modular building blocks, but not at levels smaller than those blocks. The Iewan project does not show these capabilities at all, this is mostly because the focus here was on using ecological materials that (at an end-of-lifetime situation) could be returned into the biological sphere again.

The organization of the supply side and their way of delivering the project varies significantly between the different case studies (see table 5). While both Growing Green and the Alliander project were realized through a consortium for instance, Growing Green presents a product-based project delivery whereas the Alliander project represents a process-based project delivery. Iewan shows a traditional supply side approach (where a housing association acted as the financier of the project) with a process-based project delivery. The Heijmans One on the other hand has been realized though one organization with help from an architect who delivered the design, and proposes a product-based project delivery.

As only the Alliander project has been realized from a circular perspective, this is also the only case study project that features loop securitization (through judicial contracts). Therefore the Alliander project can be considered a base- to intermediate circular service level project (the exact service level is not entirely clear (see appendix M)). The other case studies merely show a circular service level potential because of the absence of any form of loop securitization (see table 5). If loop securitization were to be implemented, the Iewan project would qualify as a base circular service level project. The Heijmans One could qualify for advanced circular services if certain additional preconditions are met (see appendix L). Growing Green could qualify for base- to intermediate level solutions if certain additional preconditions are adhered to (see appendix K).

### 7.3 Connection with other circular economy research

This section will combine the findings and discussion of this research with research done by Stigter (2016). Both this research and the research done by Stigter (2016) started out from the same point of view, which becomes apparent through the co-authorship of chapter 2, sections 3.1, 3.2, 3.4 and this paragraph of this research. After this mutual starting point, this research focused upon the organizational forms of an advanced services construction industry, whereas Stigter (2016) focused on the financial preconditions under which an advanced services construction industry might work. Connecting the findings and discussion of both researches therefore yields an overview of different possible advanced services business models and the financial pre-conditions under which they might work (figure 36). This offers a more complete picture and addresses one of the bigger subjects found in this research, namely financial uncertainty.

*Findings done by Stigter (2016)*

Based upon twelve different variables Stigter (2016) models the costs associated with a building material supplier offering its product through a lease solution. These costs are based upon rough but reasoned assumptions, the author finds that it is necessary to make these assumptions due to the lack of research done in this field (an aspect that was already noted in chapter 2 of this research). In order to be able to make reasonable assumptions, Stigter (2016) uses the example of a steel beam, this has the advantage that use can be made of historic steel prices which are well documented.
After running analyses with changing variables, Stigter’s (2016) research shows that capital gain due to a rise in resource prices is essential in enabling profitable lease solutions for building materials. This has to do with the following two arguments: first there are only two sorts of income that must outweigh the expenses; capital gain and lease income. A drop in capital gain can logically only be compensated by a rise in lease income, which could make this solution un-preferable when compared to a ‘traditional’ linear situation. Furthermore the variable ‘capital gain’ shows to influence the internal rate of return to a great extend. A decline in capital gain by just 2% (i.e. a decline in resource prices by 2%) causes a decline in the internal rate of return around 7.7%. This shows that the profitability of a lease-solution for building materials is dependent upon resource prices, making these lease-solutions volatile (as it was already stated in the outset of chapter 2 that resource prices are becoming more volatile).

Furthermore Stigter (2016) finds that it is necessary to take a ‘substitution risk premium’ into account when modelling the costs of lease-solutions. This substitution risk premium is necessary because of two factors: first regulation might change over time, rendering a material obsolete after a period of time because it does not comply with regulations anymore. Second today’s building materials might not be the building materials of tomorrow, influencing future demand for these materials.

It is important to note that Stigter (2016) recognizes that his research is limited as it only considers one product, a steel beam. Furthermore it lacks comparison opportunities with other research, and the calculations are largely based upon (controlled) assumptions.

### 7.4 Discussion

This section will discuss the findings from the interviews, case studies, and Stigter’s (2016) research in the light of the earlier chapters of this research. In this way, this discussion will place the findings in the conceptual framework as it was developed in this research, as such forming the validation of this framework and foregoing theory. At those points where foregoing theory does not suffice to explain the interview findings, use will be made of additional literature when available.
Applicability of the business model prototypes

In general it can be stated that the respondents acknowledge the analysis made earlier on in this research, which resulted in a list of requirements and business operations for the service provider. Findings from the case studies however, suggest a minor addition to the business operation of ‘picking the right products and services’. Since the case studies show that it might also be beneficial to deliver advanced circular projects based on products (see section 7.2). This reasoning follows from the following example; if a look is given to each of the case studies (as presented in table 5) and it is assumed that they would be advanced circular projects, this would in turn raise the question what the supplying parties end-up with at an end-of-loop situation. In the Iewan case (which is process-based), the supply side would end up with several materials that cannot be redeployed in any way (e.g. the processed hay) or materials of which the redeployment capabilities are unclear. In the Alliander case (which is also process-based), the end-of-loop situation will yield several very specific materials (because they were tailor-made for this project) of which the redeployment capabilities are unclear. In both the Heijmans One and Growing Green case (which are both product-based) the supply side would be left with a clear product at an end-of-loop situation. As these products could be sold multiple times over a given period (possibly with minor changes), there could be a clear market for these products, and thus a clear redeployment potential. This shows that product-based delivery of advanced circular projects could possibly lower the earlier discussed substitution risk premium (see section 7.1 & 7.3). In effect this aspect shows that besides the necessity of offering of clear products towards clients in a circular economy (see chapter 4), it might also be beneficial to base the entire delivery of a project on a clearly defined product as well.

However, as already was questioned in section 6.4, the business model prototypes are not found to be readily applicable in today’s construction industry. For the interviewed parties a base- to intermediate model might be more fitting. This base- to intermediate model could be based upon service models as can be found in for instance the Tennet or Alliander case (see appendices F & M). It does need to be said that these base- to intermediate circular services models will most likely result in an incremental environmental gain instead of a radical environmental gain, as found by Tukker (2004) and discussed in chapter 6. These models are however, as shows from the aforementioned interviews and case studies, already feasible in the construction industry of today.

In the long term however, the developed business model prototypes were seen as probable, although some variants might be more probable than others. It seems that variant 1 for instance is not seen as a probable model to be implemented by the interviewees. Even though it showed from analysis earlier that this model comes closest to the theory of the circular economy as it was outlined in this research. Nevertheless in the end it might be unsurprising that this model was not picked by any of the interviewees, as all of the competences would need to be present within the service provider’s own organization. This is something that probably will not occur easily due to the earlier discussed fragmentation of the construction industry. Next to variant 1, also variant 4 was not seen as a probable model throughout the interviews. It is hard to say what could be the reason for this, as variant two (also with an organizational stretch) was seen as probable by one of the respondents. Probably it comes down to the wish of the interviewees to tie the suppliers to the project with a lease-solution too, in that way ensuring that the suppliers are similarly incentivized. This could also be a reflection of the earlier system-based trust that is apparent in the construction industry.
Even though variant two was seen as probable (albeit by one party, with some serious considerations), it needs to be said that from the interviews both variants three and five were seen as more probable (figure 37). A possible explanation for this can be found in the fact that of the developed variants, these two bear the highest amount of similarities with the current construction industry. Especially if these variants are realized through consortia they show a resemblance towards public-private-partnership constructions that are becoming more common in the construction industry. A possible variant 5 solution (albeit without a consortium) can already be found in the Heijmans One case study, where the architect forms a supplier (for this to become an effective circular solution, the project would need to adhere to several additional requirements (see appendix L)). This shows that even though the interviewees do not regard the prototypes as presently feasible, they might be closer to real-world implementation than perceived.

![Figure 37: The two preferred prototypes by the interviewees, variant 3 (left) and variant 5 (right) (own image).](image)

**Who picks up the role of the service provider?**

The question as to what party would be able to pick up the role of the service provider remains somewhat unanswered. Should this indeed be a new entity in the construction supply chain or is one of the current parties suited to perform this role? Through the interviews it became clear that two contractors would perform as a service provider in the business model prototypes, whereas one contractor / developer seemed reluctant to adopt this role. The maintenance provider would prefer to be a supplier under the developed models. It would therefore seem that, first of all it depends on the personal preference of the parties whether they would act as a service provider or as a supplier. With the added notion that parties such as contractors, that are higher up the supply chain might see more chances to act as a service provider. A notion that does not hold to be true when compared with the literature review of this research, where it showed that the competences inherent in an organization determine the capability to act as a service provider. Therefore it is curious that parties like contractors and developers see themselves as fit to perform the role of the service provider as they reflect upon their own role as one of merely coordinating or assembling. This task does not call for many of the determined competences, however in the light of the fragmented supply chain it might also be these parties that are able to attract the needed competences the easiest, as this is part of their current operations already.

If these observations are combined with the findings that the interviewees have a preference for variant 3 and 5, and for operating in consortia, it becomes clear that the topic of vertical integration can be debated. Since, if the opinions of the interviewees represent the broader view of the construction industry, vertical integration in a circular construction industry will be realized through forming consortia. In that case it would be more fitting to speak of quasi-vertical integration (figure 38). Evidence provided by Oliva and Kallenberg (2003) also indicates that vertical integration is not likely to occur when companies that are already present in a certain industry start delivering services. Therefore if the service provider would not be a new entity, but instead be an existing party in the construction
supply chain, this role would most likely be formed through a consortium of different parties. In this consortium, parties that are currently coordinating the building process might be best suited to perform a leading role (a de facto service provider). However, these leading parties would be heavily reliant upon external suppliers to obtain enough competences for the realization of the project. Which might make it difficult to deliver the agreed upon performance in an efficient way. Next to these observations, the costs that are associated with setting up a consortium can be quite high (Straub, 2007). It is therefore that the Dutch government generally does not enter into these contracts for projects that are worth less than €25 million (Rijkswaterstaat, 2012). Considering these aspects it seems that advanced circular services projects that are delivered through variants 3 & 5 with a consortium would therefore need to be of a considerable size.

However, variants 3 & 5 do not need to be realized through consortia (see section 6.3), which is illustrated by the Heijmans One case for example. In that case the contractor was mostly responsible for the development and realization of the product, with some input from the architect. The architect in this case delivers design competences towards the project, but does this a supplier without any further ownership or incentivized connection towards the project (i.e. a variant 5 case). In such a case the amount of suppliers might be limited and therefore also the reliance upon these suppliers throughout the project could be limited. Arguably though, also the projects that could be carried out in this way might be smaller (but perhaps have the ability to be built in series). As this case study is not circular, a direct comparison is hard to make and either the architect or additional parties might be needed to be able to make this project circular. The degree to which the argument will hold that a consortium is not needed (or could be quite small), therefore still depends upon the internal competences of the service provider, as can also be seen from the Heijmans One example.

If on the other hand the service provider would be a new actor in the building supply chain, it can be questioned whether this actor would be bound to project realization through consortia as well. It could for instance be the case that an established company from another industry finds itself with all the needed competences to deliver a building through advanced circular services (or very specific competences that are as of yet absent in the construction industry). In such a case it can be doubted whether variants 3 and 5 would turn out to be the most relevant business model prototypes. Which variants will be the most relevant in that case is however not clear at this point. What is clear is that if the new actor would not be as dependent upon external suppliers as an existing actor, this could be an important advantage from a circular point of view.
Obstacles for the implementation of the prototypes

Despite seeing the variants as probable, the interviews showed some challenges that could limit this probability of use. Two of the biggest challenges that were identified through the interviews, were the financial and judicial circumstances under which the developed business model prototypes could function effectively.

This financial aspect is in line with the findings from the analysis in chapter 3, where it was presented as the second biggest challenge after the organizational problem. From the interviews it followed that in particular future financial uncertainty is of concern. Stigter’s (2016) findings deal with this uncertainty and show that the profitability of circular lease-solutions is mostly dependent upon resource price levels. Thereby also acknowledging the statement as it was made in chapter five of this research that the circular economy does not need to be sustainable under situations where resource prices are not increasing. Since the incentive for the underlying lease-solutions will not be present in that situation. Furthermore Stigter’s (2016) research states that a ‘substitution risk premium’ is needed in order to accurately model the costs of a lease-solution for building materials. The underlying reasoning for this premium follows the same arguments that were found in the interviews, where the interviewees expressed their concerns about the ability of certain products to be redeployed in another loop. This shows that this is a factor to be reckoned with, however Stigter’s research also shows that the substitution risk premium does not affect the internal rate of return of a lease-solution in a more pronounced way than any of the other modelled risk premiums.

Legal uncertainty was found as an obstacle through interviews with two actors that are already involved with implementing or comprehending the circular economic concept and one that is as of yet not doing so. The judicial uncertainty affects two different aspects; first, under current legislation it is hard to prescribe separate rules and owners for different building components, as regulations generally affect buildings as a whole. Second, under the influence of progressing legislation over time it become hard to determine whether a component that is produced now, will still be fit for use in the future (thereby the legal argument also contributes to the substitution risk and the height of its premium). These are valid points of concern that previously were not considered to this depth, but are not investigated further here as they are beyond the scope of this research. What can be said is that the legal uncertainties might decrease for the following three reasons:

1. The product or project under development involves few stakeholders, in this way the amount of connecting point may decrease (prototype variant 1 would even further diminish this uncertainty).
2. Also a new-built project might have an edge over a renovation project when it comes to the amount of legal uncertainty, as with a new-built project fewer connections and or de-coupling points to an existing structure might be necessary for the realization of the project.
3. Thirdly, flexibility in the design to accommodate for future changes in regulation (although these might be unknown) might increase the ability of (parts of) a project to be redeployed in other loops.

These three aspects might reduce the legal uncertainty, and thereby part of the substitution risk premium.

Furthermore limiting the immediate applicability of the business model prototypes is market demand. From the interviews it followed that there is a need for a clear market demand for
the implementation of these models, which is as of yet not present in the construction industry. This confirms the findings made by Loppies (2015) stating that the ‘right’ demand needs to be present in order to realize the circular economy. However it also followed from the interviews that this market demand is expected to manifest itself in the future, and it can be as simple as one client asking for a circular project in order for the models to become relevant. Also projects like that of Tennet and Alliander (Appendices F & M) show that market demand (albeit for base- to intermediate circular services) is starting to appear. To what degree market demand will manifest itself for advanced circular services remains, as of yet, unclear. As follows from the circular services level framework, sustainability can also be guaranteed through other than advanced circular services solutions. Therefore, sustainability alone would not be enough motivation to enter into advanced circular services solutions. When a look is given at the Alstom-case (section 5.1) and other cases researched by Baines and Lightfoot (2013), it seems that the outsourcing of risk is the main reason for a company to enter into advanced services. When translated to the construction industry, this would mean that market demand for advanced circular services is most likely to arise with parties whose housing needs are uncertain over longer periods of time (e.g. parties entering a new market, parties operating in volatile markets, or parties that cannot afford the initial investment costs associated with housing). Examples of parties that would demand these services therefore could be: parties that deal with a temporary demand, new businesses (start-ups), and/or businesses that need to be on a particular location for the duration of a particular contract (e.g. maintenance functions in the Alstom-case (section 5.1)).

It also became clear that as suspected, innovation (whether incremental or radical) is needed in several sections of the construction industry in order for the business model prototypes to become effective (As was for instance exemplified in one of the sustainable projects of the interviewees, where a housing association acted as a financier (see appendix J)). In that light, the choice for the sustainable business model framework by Bocken and Short (2015) over that of for instance Osterwalder and Pigneur (2010) seems justified. Furthermore it is interesting to see that three out of four interviewees see chances for technical installations to be leased as opposed to other building components. This points towards the fact that different solutions might be needed for different components of a building. What is also interesting is that technical installations are one of the few components in a building that are being developed with a growing knowledge basis, and are part of manufacturing industries. Perhaps this is one of the reasons why these components are viewed upon as already suitable for lease-constructions. What is clear that, also without the circular economic concept present, Dutch housing associations already started with outcome-based solutions for technical installations (Appendix T4).

Limitations
As the sample was quite small, it can be questioned whether the findings made in this research reflect the general opinion of the construction industry. Also, some of the interviewees were less familiar with the circular economic concept than others, which might impede the validity of their opinion on specific circular economic subjects. It does however not refrain them from commenting on the degree of which the developed business model prototypes seem probable to them. Which is why it is the belief of the author that the business model prototypes and underlying reasoning are properly reflected in this research. However statements made in this section about for instance the expected market demand (and similar future expectations) and possible preferences for the prototypes are partly dependent upon these interview findings. Therefore in order to enhance the validity of the results, more interviews would need to be conducted. Preferably these interviews would be conducted in a similar way, with both parties that are familiar with the circular economy and
parties that are not. Another way of enhancing the validity of this research would be to set-up a questionnaire according to the findings of this research, followed by in-depth interviews with some of the respondents. This however goes beyond the scope of this particular research project.

7.5 The service provider in practice
After the presentation of the findings and the following discussion, this section forms the conclusion of this chapter. Therefore this section focuses on the way the service provider may operate in practice with input from the earlier sections and preceding chapters. Essentially sharpening the first part of the main research question that deals with the organization of the research provider through the creation of a roadmap. Afterwards a perspective on the relations between the advanced circular service provider and the current stakeholders in the construction process is provided through a map of the consequences for each stakeholder. It is important to keep the limitations in mind that were stressed in section 7.4 before reading this section, also the consequences for the different stakeholders as presented in this section are only valid for variants 1, 3, and 5. This as it followed from the earlier sections of this chapter that if the advanced circular services prototypes are to be implemented at all in the near future, these variants would be the most likely forms of appearance (variant 1 is chosen here to represent a case of a service provider in the form of an external stakeholder entering the construction industry and variants 3 and 5 in case of service provider in the form of an internal stakeholder of the construction industry).

A roadmap for an advanced circular service provider
The input for this roadmap is provided by chapter 6 where the requirements, business operations, and different variants of prototypes were presented. However after the foregoing findings and discussion some minor changes and additions can be made to this information. Also a certain order in the requirements and business operations can be suggested, this has resulted in a roadmap that is presented in this section.

1. **The circumstances meet the requirements** as set out in chapter 6. This means, amongst others, that there is a clear demand from a client for advanced circular services, which is not too specified.

2. **The supplying party is willing** to deliver advanced circular services, and expects resource prices to rise in the future. This in order to guarantee the sustainability of the offered advanced circular services (see sections 5.3 and 7.3).

3. After these requirements are met, **the service provider starts with determining the lifetime of the building**, which is dependent upon the length of the contract with the client. After all, it is for this period of time that the agreed upon performance needs to be met by the service provider.

4. **The service provider picks** (process-based project delivery) or develops (product-based project delivery) **those products that are able to meet the agreed upon performance.** Both process-based and product-based project delivery are viable options for the service provider to take, they do however come with their own set of characteristics (see table 6). Process-based project delivery is probably more suitable for larger ‘one-off’ projects (although this might decrease the circular potential (see chapters 3,4, and 6)), and might therefore be more attuned to current construction industry practices. Product-based project delivery might be more suitable for smaller projects that might show the possibility to be built in series (e.g. Growing Green, Heijmans One). This type
of solutions might also enhance the circular potential of projects (see chapters 3, 4, and 6) and might reduce several of the uncertainties as explained in section 7.4. These products will arguably only be able to be built in series (and thereby reduce several uncertainties) if they provide enough rigidity so that several lines of products can benefit from the same basis. On the other hand however they need to be as flexible as needed (preferably not more as this might lower the amount of rigidity) in order to still be able to provide the specific performance that is sought after by each individual client (as was identified in figure 24). Therefore in case of a product-based project delivery the offered product needs to be both rigid in the underlying system and flexible in the eventual specific appliance of the product in order to guarantee the benefits as they are portrayed in this section.

<table>
<thead>
<tr>
<th>Process-based project delivery</th>
<th>Product-based project delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not that fit for repetition with variants 3 and 5 (see sections 6.3 &amp; 6.4)</td>
<td>Fit for repetition*</td>
</tr>
<tr>
<td>Unclear redeployment opportunities</td>
<td>Clear redeployment opportunities</td>
</tr>
<tr>
<td>Increased transaction costs in case of a consortium (due to the repetition argument)</td>
<td>Possibility of lower transaction costs (due to the repetition argument)</td>
</tr>
<tr>
<td>Increased substitution premium (due to unclear redeployment opportunities)</td>
<td>Decreased substitution premium (due to clear redeployment opportunities)</td>
</tr>
</tbody>
</table>

Table 6: The different characteristics of both process-based and product based delivery (input follows from the discussion in section 7.4) (own table)

* The repetition argument as laid out in sections 6.3 & 6.4 for both variants 3 & 5 is expected to diminish (not to disappear completely) with a product-based project delivery. This as the development of a product takes away several uncertainties (as can be seen in this table), next to that the same organization (either in the form of a consortium or not) can be expected to produce a certain product over a certain period of time, thereby escaping the ‘one-off’ project as is common in the construction industry today. Obviously these observations only hold true when the product adheres to the prescribed qualities as clarified in this section.

5. **The service provider needs to deal with the specific characteristics of the construction industry and needs to check the decoupling points.** The service provider needs to deal with these characteristics through the choice for one of the developed variants. This choice depends upon the competences that are apparent in the organization of the service provider (as explained in chapter 6), to deliver upon the demand of the client that was identified in the preceding steps of this roadmap. In other words, where the first steps (1-3) of this roadmap act as an identification of the question that is asked by the client and the best way to deal with this (4), this step couples those identifications with the abilities of the organization of the service provider. After the identification of these abilities a choice is made for one of the developed variants under chapter 6, essentially dealing with the specific characteristics of the construction industry (as explained in section 6.3). The decoupling points will always be present when the realized building consists of different product-lifetimes and/or is made up out of products that are delivered through different stakeholders.

6. **The service provider takes on the operational responsibilities towards the client regarding the lease** during the contract period. After the identification of the question and the appropriate response by the service provider, the solution is operationalized for the duration of the contract.

7. **The service provider makes sure the used products are redeployed at the end of the contract or at an end-of-loop situation.**
Consequences for the different stakeholders in the current construction industry

As the whole concept of a service provider and the different variants are quite abstract, this section will offer a perspective on the relation between the advanced circular service provider and the current stakeholders in the construction industry. Thereby essentially clarifying the answer to the second part of the main research question. In order to do so, the consequences that the delivery of advanced circular services might have on the current construction industry stakeholders (as introduced in chapter 3 & 4) are mapped in the table below (table 7). These consequences follow the findings done in this research, and with the absence of real-world implementation of advanced circular services in the construction industry (and the acknowledgement made in section 7.4 that this question remains somewhat unanswered through this research), they therefore form a (controlled) prediction.

<table>
<thead>
<tr>
<th>Variant</th>
<th>1</th>
<th>3</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User</strong></td>
<td>Unchanged</td>
<td>Unchanged</td>
<td>Unchanged</td>
</tr>
<tr>
<td><strong>Owner</strong></td>
<td>Disappears</td>
<td>Disappears</td>
<td>Disappears</td>
</tr>
<tr>
<td><strong>Financier</strong></td>
<td>Disappears / or recipient of income stream</td>
<td>Disappears / or recipient of income stream</td>
<td>Disappears / or recipient of income stream</td>
</tr>
<tr>
<td><strong>Main contractor</strong></td>
<td>Disappears</td>
<td>Part of service providing consortium</td>
<td>Part of service providing consortium</td>
</tr>
<tr>
<td><strong>Project Developer</strong></td>
<td>Disappears / Service provider</td>
<td>Part of service providing consortium</td>
<td>Part of service providing consortium</td>
</tr>
<tr>
<td><strong>Supplier</strong></td>
<td>Disappears / Service provider</td>
<td>Supplier / Part of service providing consortium</td>
<td>Supplier / Part of service providing consortium</td>
</tr>
<tr>
<td><strong>Sub-supplier</strong></td>
<td>Supplier / (product designer/composer)</td>
<td>Supplier / (product designer/composer)</td>
<td>Supplier / (product designer/composer)</td>
</tr>
<tr>
<td><strong>Specialist</strong></td>
<td>Supplier</td>
<td>Supplier / Part of service providing consortium</td>
<td>Supplier / Part of service providing consortium</td>
</tr>
<tr>
<td><strong>Facility manager</strong></td>
<td>Disappears</td>
<td>Disappears</td>
<td>Disappears</td>
</tr>
</tbody>
</table>

Table 7: The consequence of the choice for one of the variants for the stakeholders of the current construction process (own table)

Through table 7 it becomes clear that there is still a lot of uncertainty surrounding the effects of a choice for variant 1 on the current stakeholders in the construction industry. Variant 1 is included in this overview for reasons that were stated at the outset of this section and will, according to the findings, (most likely) only appear in the form of an external stakeholder venturing into the construction industry. The fact that this stakeholder is as of yet not present in the construction industry, explains part of the uncertainty about the consequences on the current stakeholders. What can be said is that the position of the user will remain unchanged (except it is clear what product will be offered towards the user (see figure 24)) when compared to the position in figure 7. Also the ‘traditional owner’ will disappear, as the service provider will retain ownership of the delivered products. This will
make the role of the traditional owner redundant (this holds for all of the developed variants in this research, so not merely for those depicted in table 7). Furthermore the financier will either disappear in the case where the service provider has enough financial means to effectively operate the lease solution. If this is not the case the financier will become the recipient of the income stream during the duration of the contract (e.g. the studies examples in chapter 5). Since in a variant 1 case it is assumed that the service provider has got all of the needed competences within its own organization to provide the agreed upon performance, this would mean that all of the other stakeholders in the construction process are no longer needed.

For both variant 3 & 5 about the same consequences can be expected for the current stakeholders in the construction industry depending if the services are delivered through a consortium or not. When variant 3 & 5 are conducted through a consortium, the main contractor will most likely be part of this consortium because of its capabilities to attract competences to the project (see section 7.4). If the consortium is absent however it can be questioned whether the main contractor will be of any use if its only capability lies in the gathering of competences (i.e. acting as a chain-conductor). Therefore if the main contractor does not possess any of the needed competences (see section 6.3) other than gathering these, this stakeholder will disappear out of the process. The same thing can be said for the project developer, also with this stakeholder more competences are needed than just the ability to gather those needed for the project in a situation where no use is made of a consortium in variants 3 and 5. For both of these stakeholders it is therefore useful to look at the role of the contractor/developer in the Heijmans One case (appendix L). Both a supplier and specialist would retain their role as a supplier in case no consortium is used in a certain project. If a consortium is used these parties could either be a supplier or, depending on the matter of impact or complexity of the product they offer, part of the service-providing consortium. A sub-supplier will in all cases most likely retain its current role. This as the impact of its contribution on the entire project (as opposed to that of a supplier or specialist) might not be big enough to be part of the service-providing consortium. The architect will in all cases displayed in table 7 arguably become a supplier in the form of a product or industrial designer, or in the form of a composer of the needed products for the agreed upon performance if the service provider lacks overall design competences. This is because of the nature of the design that is needed in an advanced circular construction industry, which focuses on products. Lastly, the role of the facility manager will disappear completely in its current form (in all of the variants), as the service provider (and possibly those suppliers connected to the service provider with an incentivized contract) will fulfil the operations that are traditionally performed by this actor.

**Concluding remarks**
The concluding remarks of this chapter will be noted under chapter 8 and form the concluding remarks for this research as a whole.
8. Conclusions, recommendations, reflection
This chapter will present the conclusions, recommendations, and reflection of this research as a whole.

8.1 Conclusions
This report introduced five different business model prototypes based upon the inherent knowledge of parties on their competences in the construction industry. These business model prototypes were developed following an extensive literature review and focused solely on advanced circular services solutions. This was done for two reasons: first this type of business model is as of yet unknown in the construction industry (as can be seen from the circular service level framework). Second, this type of business model can be expected to deliver radical environmental gain. With the development of these business model prototypes the first part of the research question is answered (How to organize the service provider in such a way that its role adheres to the definition and principles of the circular economy).

Afterwards these models were laid out in front of several practitioners in order to answer the second part of the research question (How does this organization relate to current supply side stakeholders in the construction process). However, these interviews set in motion several subsequent case studies that also influenced the underlying rationale of the business model prototypes. As it was found through these case studies that it might also be beneficial to deliver advanced circular projects based on products instead of processes, these findings have been included in a roadmap.

In general the interviews found that the developed business model prototypes are not seen as directly applicable in the construction industry, on the long term however they were seen as probable. While the interviewees showed some convincing arguments as to why they perceive these prototypes as not directly applicable (see the obstacles that are explained below), from the case studies some examples came forward that could go a long way in circularity. It can therefore be argued whether the prototypes are really as unfeasible in the short run as the interviewees believed.

That being said, there are several convincing explanations that can be given why the developed prototypes are not seen as directly applicable to the construction industry:

1. For advanced service model prototypes to work, innovation has to take place in multiple places within the construction process. These innovations are not always seen as likely to occur in a short timeframe.
2. The respondents in this research perceive financial uncertainty around the business model prototypes (this was also found as one of the obstacles of implementing the circular economy in chapter 3 of this report). Research by Stigter (2016) shows that this uncertainty can be brought down to two factors. First, the profitability of lease-solutions depends heavily upon resource prices. Second, the financial value of materials or products used in a construction project depends on their usability at the end-of-loop situation (i.e. a substitution risk), which brings us to the third explanation why the developed business model prototypes are not directly applicable to the construction industry.
3. There is legal uncertainty surrounding the materials and products that are used in a construction project. Building regulations for instance tend to be progressive and/or changing over time, this could influence usability of products that are currently
present in one building to be re-used again at the end-of-loop situation. This also affects the financial value of the inserted materials and products the aforementioned substitution risk). However, the following factors could arguably diminish these uncertainties; a limitation of the amount of stakeholders that take part in a project, opting for new-built projects over renovation projects, and allowing for flexibility in the design to accommodate for future regulation changes.

4. As of yet there is no clear market demand for advanced circular services. While from the case studies it shows that some market demand has manifested itself for base-to intermediate services. This might have something to do with the relatively small group of potential clients. As the main reason for a client to move into advanced services solutions seems to be the outsourcing of risk related to the investment, possible clients can be found in the following group; parties that deal with a temporary demand, new businesses (start-ups), and/or businesses that need to be on a particular location for the duration of a particular contract.

With regard to the second part of the research question (how does this organization relate to current supply side stakeholders in the construction process), the findings indicate that there is no definitive answer to be found yet. First of all it seems to depend upon the personal preference of the supplying parties whether they would act as a service provider or as a supplier. With the added notion that parties such as main-contractors or developers that have a coordinating role in today’s construction industry might be closer to perform the role of the service provider. Although this task does not call for many of the identified competences, in the light of the fragmented construction supply chain it might also be these parties that are able to attract the needed competences the easiest, as this is part of their current operations already.

If these observations are combined with the findings that the interviewees have a preference for variant 3 and 5 and for operating in consortia, it becomes clear that in these cases it would be more fitting to talk about quasi-vertical integration in the construction industry as opposed to vertical integration. Next to these observations, the costs that are associated with setting up a consortium can be quite high, it therefore seems that advanced circular services projects that are delivered through variants 3 & 5 with a consortium would therefore need to be of a considerable size. One of the case studies however exemplified that a consortium might not be needed in order to deliver advanced circular services through variants 3 and 5. In such a case the amount of suppliers might be limited and therefore also the reliance upon these suppliers throughout the project could be limited. Arguably though, also the projects that could be carried out in this way might be smaller (but perhaps have the ability to be built in series). From the map of consequences for the different stakeholders it became clear that the choice for or against a consortium could have significant consequences for the current stakeholders in a construction project. One example could be that without a consortium there would be no rationale for the presence of a main-contractor that merely ‘coordinates’ in a circular project that is carried out according to variant 3 or 5. If a consortium would be used with variant 3 or 5, this same stakeholder would have added value through this very same capability, ‘coordinating’ the project, and would likely be a part of the service-providing consortium.

If the service provider would be formed through an external stakeholder that is not present in the industry yet, the consequences for the current stakeholders in the construction industry remain unclear. It did show from the consequence map that it might be the case that all but one stakeholder (the financier) may disappear from the construction process (if the external party would be operating through variant 1). The entrance of an external party
with a high degree of competences could therefore have a profound impact on the current construction industry.

Given the fact that the developed business model prototypes are (arguably) not likely to be implemented in the short-term, the implementation of the circular economy would likely be restrained to basic-, to intermediate services business models. Evidence of which can already be found in the current construction industry, as can be seen from some of the examples introduced in this research. This will most likely limit the environmental gain by implementing the circular economy in the construction industry to an incremental level.

8.2 Recommendations
This section will give some recommendations that follow from this research, first some recommendations for further research will be given. Second, a few recommendations will be given for the supplying parties in the current construction industry.

Recommendations for further research

- First of all, it is recommended to further research the findings of this research in order to enhance their validity. This was already suggested in section 7.2 and could be done by for instance setting up a questionnaire in order to get a bigger sample, and afterwards conducting several in-depth interviews (preferably with the same set-up as in this research) with some respondents to the questionnaire. Also the proposed roadmap and consequences could be included in this kind of research.
- In order to make the most of the suspected incremental environmental gain in the short-term, further research should focus on developing complete (business) models for basic- to intermediate circular services. This in order to make sure that the incremental environmental gain will be fully exploited. Valuable input for this research could come from practice, where some of these projects are already underway.
- For the business model prototypes to become relevant, it is necessary to address the legal uncertainties. Further research should focus on ways to ensure proper building regulations without making it impossible to re-use current building materials and products. Policy makers should rethink their regulations surrounding subsidies as such that they do not longer form an obstacle for implementing advanced circular services.
- Further research should also focus on the (im-)probability of vertical integration as it was presented in this research. Why is it that current supply-side stakeholders in the construction industry and other industries do (generally) not view this as a viable option?
- Practical implementation of the developed business model prototypes is currently absent. It could therefore be interesting for further research to find an interested party that would want to operate part of its business (or launch a pilot-project) according to the developed roadmap and prototypes.

Recommendations for supplying parties in the construction industry

- Supply side parties that have taken note of the possible obstacles, but are confronted with a demand from a client and still wish to pursue advanced circular services solutions are encouraged to do so following the developed business model prototypes and roadmap. This in order to set an example for others, to possibly create radical environmental gain and to provide a unique research opportunity.
If supply side parties opt to experiment with advanced circular services, findings from this research show that it could be wise to start with a project that:

1. Focuses on product-based project delivery (preferably the product can be produced in-house as much as possible to lower the amount of stakeholders involved, and is a part of the supplying party's core business).
2. Allows for a limited amount of total participating stakeholders (considering recommendations 1 & 2, this product and project could arguably be quite small)
3. Focuses on a new-built solution (to avoid some judicial obstacles)
4. Studies the possibilities of the amount of rigidity vs. flexibility in the design (in order to avoid some judicial obstacles and to lower the substitution risk premium)
5. Would avoid project delivery through variant 3 or 5 with a consortium (as this might enhance transaction costs and therefore lower the probability of a marketable project outcome)

All current supply-side construction industry stakeholders are encouraged (whether they pursue advanced circular projects or not) to reflect critically upon (1) the competences that are incumbent in the organization, and (2) upon the uniqueness of the products that are produced within the company. This last point as a unique product (with clear, unique selling points) could arguably be easier to be implemented in possible advanced service-providing solutions.

Practitioners are encouraged to also pursue base- to intermediate circular services projects if they should present themselves, as they can represent new business opportunities and a possible (incremental) environmental gain.

8.3 Reflection

In general I would say that the research process has been really interesting, the topic at hand (in a great part due to its novelty) sparked enthusiasm by all contacted actors in line of this research. This novelty did however present some of its own challenges. It took a great effort for instance to arrive at a definition and principles of the circular economy that could be used as a basis for this research. Shaping the material around the circular economy has been an on-going pursuit throughout the whole research process and as such forms a sizeable part of this report. This aspect should not be underestimated by anyone attempting to research the circular economy, it will take a significant amount of time and resources throughout your research project (at least in the near future). In the end I think the way the circular economy is captured in this report is more than satisfactory for at least my own expectations and it is my hope that other scholars find inspiration in it. Getting practitioners to agree to an interview to share their thoughts and experience turned out to be relatively simple. It seems that interest in the topic of circular economy is high with these parties at the moment. The interviews themselves turned out to give valuable input into the research and threw up some interesting examples of sustainable projects that are currently underway in the construction industry. Overall the process therefore was smooth, the only thing I would do different next time is to allow for more time while planning the research phases. Several activities took longer than initially anticipated. In the end I have no regrets that I pursued this ‘ambitious’ (as it was deemed by some) agenda as it has been rewarding throughout the whole process and I would have not settled for less.

But this reflection should also give a critical look at the expectations that were set-up upfront. I had the hope that implementing the circular economy in the construction industry would ‘liquify’ the industry. With expectations that in the foreseeable future only basic- to
intermediate circular services business model will be implemented, this liquification will probably not occur in such a dramatic fashion. Also the circular economy was studied under this research project as an economic system with a major catch in the form of sustainability gain. This sustainability gain might be lower than expected due to the, at least temporary, rejection of advanced services business models. The basic- to intermediate business models do not require a drastic change in business operations and will therefore only curb some current practices.

On the other hand it should not be forgotten that the drastic change that goes together with advanced circular services models will lead to some side-effects of which it can be questioned whether they would be positive. The main concern is that in taking away responsibilities from the client in order to provide advanced circular services, it will become the industry that is almost solely responsible for supplying the client with his needs. In a case where there (for whatever reason) might not be sufficient competition, this might lead to the monopolization of the services that can be delivered. This will in turn result in sub-optimal solutions for the client. It is therefore important to keep track of market developments in order to avoid these kinds of situations.

Notwithstanding the fact that the developed business models are not directly applicable, this research has given insight into the way these models might work. They did this in such a way that several practitioners could see these as useable on the long-term if circular economy might take off. Therefore, despite of their current inapplicability, the developed models show insight in how an advanced services circular construction industry might operate. If I could hazard a guess who will demand these kinds of models (and I already did in the concluding remarks), I would think of companies with an unpredictable need for housing (therefore encapsulating the risk with advanced services). The private real estate market therefore seems an unlikely client, these models will under the prescribed conditions mostly be fit for professional organizations and utility buildings.

With respect to the environmental aspect, it is not necessarily devastating that the circular economy probably will not fulfil all of its sustainability promises. Sure it is a let-down, but as this research has shown, many actors in the construction industry, also those from whom it might not be expected at first sight, are well under way in developing sustainable projects. They do this either with or without the circular economic concept under the influence of changing client demands. Also radical environmental gain through circular advanced services models in the construction industry might be closer than we think, as one of the interviewees in this research put it: ‘a circular project might just be a phone call away’.
References


**References case studies**


Glossary
The list below forms a glossary of terms and concepts in this report, with these terms and concepts in bold characters. The sections in which they appear in this report are shown in italic characters.

**Biomimicry (2.1)** - The design and production of materials, structures, and systems that are modelled on biological entities and processes.

**Blue economy (2.1)** – Nature inspired technologies that can affect the economy.

**Building**
- **General (3.1)** – A collection of interrelated parts or components at different scale levels, the sum of which makes up a building (Prins, 1992).
- **In the circular economy (4.1)** – A collection of products that together form an entity that can be described as a building. A building is as such a collection of interrelated products at different scale levels (adapted from Prins, 1992).

**Business model prototypes (2.4; 6.2; 6.3; 6.4; 7; 8)** – A business model that is modelled after the framework by Bocken et al. (2015) but is yet to be implemented in real life.

**Circular economy**
- **Biological life cycle (2.1)** – One of the main cycles within the circular economic concept, its main aim is to let materials find their way back into nature after their economic lifetime has expired.
- **Concept (2.1)** – The circular economic concept as it has been drawn up by the EllenMacArthur Foundation (2013).
- **Downgrading (2.2)** – The process where materials or resources are taken from one product and used in another product that is deemed to be of a lower quality than the product where the material originated from.
- **Technical life cycle (2.1)** – One of the main cycles of the circular economic concept, its main aim is to accommodate products during their economic lifetime in one of the attached loops, and to ensure their use in another loop after that lifetime has ended.

**Construction industry (3.1)** – The industry that is responsible for the delivery of Buildings.

**Cradle-to-cradle theory (2.1; 5.2; 5.3; Appendices F,G,H,I)** – Theory that presents a system powered by renewable energy in which materials flow in safe, regenerative, closed loops.

**Cyclical material loops (2.3)** – A loop that ensures the circularity of a resource, material, or product by providing information about its origin, current use, and the mode of use at an end-of-loop situation.

**Decoupling-points (6.1; 6.2; 6.4)** – Connection points within a circular building where one product is connected with another in such a way that both attached products are able to be remover or replaced without damaging the other.

**Diversification (5.1)** – The process of altering products or ways of operating in an attempt to stand out amidst the competition.

**Economics**
- **School of thought (2.1; 2.3)** – Social field of science that studies human behaviour when people are confronted by scarcity.
- **System (2.3)** – A combination of more than one interrelated parts or components that shows how people deal with scarcity.

**Financial incentive (2.3)** – A prospect on financial merits.

**Focal firm (3.2; 3.2; 4.3; Appendix I)** – Concept from the field of supply chain management, refers to a dominant firm on either the demand or supply side of a market to which other firms direct their operations.

**Innovation**
- **Definition (3.2; 5.1; 5.2; 6.2; 7.1; 7.4; 8.1; Appendices D,G)** – The successful launching of new, improved or more competing products, services or organization structures (Straub, 2011).
- **Incremental innovation (6.2)** – Features the replacement of critical components, products, services, or organization structures (adapted from Dangelico & Pujari, 2010).
- **Radical innovation (6.2)** – Features the improvement of existing components, products, services, or organization structures (adapted from Dangelico & Pujari, 2010).
Installed base (5.1) – The amount of similar products that are already deployed in the field.

Life cycle analysis (2.1) – Economical, sustainable or impact analysis of a product or system based on the total life cycle of said product or system.

Organizational stretch

- **Definition** (5.1; 5.3; 6.3; 6.4; 7.1; 7.4; Appendix H) – Vertical or horizontal integration of a firm with the aim to incorporate business elements within the organization that it deems as needed in order to be able to perform its operations.
- **Backward stretch** (5.1) – Follows the definition, however only takes into account the core activities of the client.
- **Forward stretch** (5.1) – Follows the definition, however only takes into account the core activities of the organization itself.

Partnering (3.2; 4.3) – The development of strategic partnerships within a supply chain.

Performance (4.1; 5.1; 5.3; 6; 7.1; 7.4; Appendices F,H) – A performance is an agreed upon action of performing that results in an output, utility, goal, function or commitment whereby the product is not a goal in itself but enabling the performance (adapted from De Grauw, 2015).

Performance economy (2.1) – An economic system where products, components and services are deployed according to their performance over a given time-period.

Product-service system (5.1; 5.3) – System that is able to deliver services that are enabled by an underlying, physical product.

Raw materials (2.1; 2.2; 3.1) – Resources (either combined into a material or not) that have been extracted from earth without ever being deployed into any product before.

Regenerative design (2.1) – School of thought that attempts to design products in such a way that it leaves options for re-use at the end of the product’s lifetime.

Service

- **Definition** (3.1; 4; 5.1; 5.2) – Mainly a non-physical action or operation whereby the performance is optimized over time (from De Grauw, 2015).
- **Advanced services** (5.1; 5.3; 6.2; 6.4; 7.1; 7.2; 7.3; 8) – The highest service level according to the scale of Baines and Lightfoot (2013).
- **Basic services** (5; 6.1; 6.3; 6.4; 7.1; 7.2; 7.4; 8.2; 8.3) – The lowest service level according to the scale of Baines and Lightfoot (2013).
- **Intermediate services** (5; 6.1; 6.3; 6.4; 7.1; 7.2; 7.4; 8) – The intermediate service level according to the scale of Baines and Lightfoot (2013).

Service provider

- **Definition** (4.3; 5.1; 5.3; 6; 7.1; 8.1) – An organization that performs a service.
- **Pure service provider** (5.1) – Organization that performs a service without an underlying physical product.
- **Manufacturing service provider** (5.1) – Organization that performs a service with an underlying physical product.

Servitization (5.1; 6.2) – The process where physical products are combined with services.

Supply chain

- **Integration** (3.2; 5.1; 5.3) – Form of vertical integration within one, already existing supply chain.
- **Management** (3.2; 5) – Field of science that studies supply chains, also form of actual in-field management of an organization’s own supply chain.

Vertical integration

- **Definition** (5.3) – Form of integration where an organization might take over or merge with down- or upstream suppliers.
- **Quasi vertical integration** (7.4) – Form of integration whereby an organization does not take over the whole (or any part of) another organization in order to extend the organization’s supply chain. E.g. it could also be a collection of different parties acting together for a certain project (i.e. a consortium).
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Appendix B: Building project organization

In chapter 3 a graphical depiction of the organization of a building project is introduced (partly deduced by Segerstedt & Olofsson (2010)). It is mentioned that it is important to keep in mind that the different stakeholders in a construction project have different needs and objectives for participating in the project. Consequently figure 8 shows the different needs and objectives for the participation in a building project. However, the relations between the depicted actors are not clarified. In order to clarify these relationships, a look can be given to figure B1.

Figure B1: Relationships between the different stakeholders in a building project organization (own image, partly deduced from Segerstedt & Olofsson (2010))
Appendix C: Perspectives on a circular construction process

*This appendix is co-authored by R. Stigter (contact details can be found in appendix A)*

Under influence of the circular economy the way in which buildings are realised will change, this becomes clear when looking at the description and definition of circular economy in chapter 3, and by looking at examples of products in other markets that already claim to be circular (MVO Nederland, 2014; Deckmyn et al., 2014). As of yet there is however no precedent of what the construction process is going to look like under the influence of the circular economy. This section will therefore discuss current construction processes and their (in-)applicability with circular economy theory, this will be done through examining three different aspects that will be subject to change under the influence of circular economy implementation; ownership, business finance, and building components (i.e. the products). For these exercises the earlier established definitions and preconditions of a circular economy (chapter 3) are used, if any other assumptions are made these will be noted separately with each exercise. The result of these exercises yields an overview of the possibilities of implementation of circular economy in the construction industry.

D1 Ownership in a circular construction economy

In order to get a grasp of what the effect of implementation of the circular economy in the construction industry might have on ownership, this study will comprise a short research into what happens concerning ownership in this situation. For the exercise first a ‘standard’ construction process is depicted and explained. Afterwards a possible circular construction process is depicted and explained.

The exercise

Current construction processes generally go through several stages, these stages can be identified as: initiative, design, construct, and use. Where the initiative stage serves to define the need for a certain building or service, the design phase focuses on designing the need as it were. After the design has been made the process moves into the next phase, which is called the construction phase. In this phase construction of the design takes place, after construction is finished the use phase commences (Wamelink, 2010). The construction process as described above seems neat and clear-cut, but it becomes more complicated when the phases are coupled to the actors that are needed in order to execute the different phases, these will be discussed below.

Roles and their responsibilities

When the aforementioned phases are coupled to the stakeholders in the process, it immediately becomes clear that the construction process is a complex one (Figure D1 shows this relationship throughout the project time span based on Wamelink (2010)). During the initiative phase it is mostly up to the client to show the initiative to start a new project and think about the question what he or she needs.

Once the design phase is entered, architects and advisors usually become involved to try and design a solution for the need that was established in the initiative phase. Although the amount of stakeholders involved in this phase usually is quite small, there is no limit to the amount of advisors that can be consulted here and in complex projects it might be that there are already a lot of different actors involved in this stage.

After the design phase is finished and the construction phase starts, other actors make their way into the process. The most important entering stakeholder in the project at this stage is the contractor who is (usually) responsible for executing the design. The contractor usually is not able to construct the entire project on its own, and therefore enlists the help of sub-contractors and possibly its own advisors. The architect, earlier advisors, and client may also still be involved in this stage.
Hereafter the use-phase commences and the client starts using the commissioned project, or it sells the project to a third party, and then could possibly rent it back or not. Another important actor in this phase is the facility manager, who is responsible for taking care of the project during the use-phase.

As can be seen from the short description above, the construction process revolves around an intricate play of different stakeholders during different phases of the project. This makes for complexity, especially since the way in which the above stakeholders cooperate is different in each project, making each project a ‘one-off’ and unique. What also becomes apparent is that on the supply side there are a lot of changes throughout the process when it comes to which parties are present in the project. There is not one single actor on the supply side that is present throughout the entire construction process. On the ownership side however, changes are relatively rare and if they occur, these changes were probably foreseen at the start of the project. It can therefore be argued that the ownership side of the process is more long-term oriented (with exception of the project developer), and the supply side more short-term oriented.

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Initiative</th>
<th>Design</th>
<th>Construction</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td>Client (Project developer)</td>
<td>Client (Project developer)</td>
<td>(Client) Project developer</td>
<td>Client Project developer 3rd party</td>
</tr>
<tr>
<td>Supplying parties</td>
<td>Architect (Specialists)</td>
<td>Architect (Contractor)</td>
<td>(Architect) Specialists Contractor Sub-Contractors</td>
<td>Facility manager</td>
</tr>
</tbody>
</table>

Figure D1: Ownership and supplying parties in a linear construction process (Own image).

Implementation of the circular economy

When the circular economy is implemented in the process above, some radical changes appear to both the ownership and supplying side, as the thought behind circular economy theory is that each supplier remains the owner of their own product, thereby incentivizing them to realize more sustainable products (Ellen MacArthur Foundation, 2013). The ownership of the object under this influence therefore changes from the traditional parties towards the supplying parties, annihilating the traditional division between the two.

Furthermore, as every actor should remain responsible for their own product, this would mean that parties that are involved from the very beginning should remain the owner of their service throughout the project timeline. Therefore the architect and the specialists in the initiative phase would remain ownership over their service throughout the project’s timeline (figure D2). This process would entail that all the actors from previous phases would be added up to the actors that are present in later phases to form the ‘owner’ of the constructed object. In figure D2 this has not been depicted in such a way in order to keep the figure clear, but it also raises the question whether the abovementioned changes won’t complicate the construction process even further.
Perhaps it would therefore be more logical to have only one owner of the constructed object to which other parties provide their services. However the problem then becomes that the incentive to make a sustainable product is only valid for the sole owner, all the other actors won’t experience a change from the ‘normal’ process.

Concluding remarks

When circular economy theory is brought to the ‘standard’ construction process, the division between ownership and supplying party changes and becomes blurry. It can be argued that in this line of thought ‘traditional’ ownership disappears and shifts towards the supply side parties. This complicates the process as supplying parties, contrary to the traditional ownership parties are subject to change throughout the process and there would therefore be a lot of different parties involved that can call themselves owners. It also affects the time scope of the involved parties, where supplying parties usually have a relatively short-term involvement and ownership parties a long-term involvement, in the circular process this division has disappeared, leaving the supplying parties to have to adjust their time scope to more long-term involvement. Leaving one owner would not solve this problem as well, as it undermines the incentives that drive the other suppliers in a circular economy.

D2 Business financing in a circular construction economy

Under the influence of the circular economy, the context when it comes to business financing will change for a supplier. The changed situation is probably best described by an example; if there would be a supplier S that deals with a ‘regular’ construction project he/she would simply leave the bill for his services and receive payment. Within a circular context, the supplier would remain the owner of his delivered goods that come with his services. Instead of leaving the bill, the supplier would instead get continuous payments for the use of this service (MVO Nederland, 2014; et al., 2014).

As businesses are financed mostly by debt, these periodic payments could create problems, as financing is usually project based and it might be costly to delay re-payments on this debt as a result of periodic income. Getting a loan to finance the firm’s business could therefore become more complicated in an already complicated financing climate (Van Odijk & Van Bovene, 2014). As the economic basis to provide financing changes, financing should also evolve. First thoughts about a possible change in financing consider for example stock financing. Instead of financing the project, the financier finances the stock of materials a supplier uses (MVO Nederland, 2014). But even after that the question remains, one that is very similar to the mass-produced circular products, who will take building materials that are lodged within a building as collateral (Deckmyn et al., 2014)?

But what is the real impact of the above-described situation for a supplier, this question formed the basis of the exercise that is being described below. This exercise will
comprise a short research into what happens when a construction company decides to lease its new products to costumers instead of selling it. In order to do so, a yearly account of one of the bigger construction companies in The Netherlands is taken as a source of data in order to calculate the effects of leasing versus selling the produced dwellings. The exercise will be explained and visualised below, after which some concluding remarks will be made.

The exercise
As stated above, the basic data input for this exercise comes from one of the bigger construction companies in The Netherlands, for this exercise the focus is on the construction of dwellings. It is important to note that the company that provided the data for this exercise is involved in other activities besides realizing dwellings, other activities include infrastructure, commercial property and a relatively small amount of consulting. However this exercise is limited to the construction of dwellings in order to keep it relatively simple and therefore eliminating the need to make a lot of unnecessary assumptions, which would undermine the validity of the eventual results.

First off, tables D1 and D2 show the yearly account of the company under examination as it was stated for the year 2013. These results were thus attained with their ‘regular’ business practices. A few things stand out, like the high amount of short-term loans, and at the same time the low quantity of long-term loans, which is probably a result of the project-driven nature of a contracting company. It also explains the highest expenses category on the profit and loss account, delegated work, which is needed in order to make a project work. The other categories on both the balance sheet and the profit and loss account don’t stand out in any particular way.

Implementation of the circular economy
For the next part of the exercise, it is assumed that instead of selling the newly constructed dwellings, the company leases these to its customers. This assumption is made under influence of the circular economy where products are no longer bought by the consumer, but where the consumer merely pays for the service offered, which in this case would be living. Tables three and four show the effects of such a decision on the balance sheet and profit and loss account of the company under examination.

Further assumptions for the data below are that since roughly 27% of this company’s activities are related to the construction of dwellings, only 27% of the business income is affected, which translates to about 287 million Euros. This amount of money translates itself to about 2000 dwellings against an average construction price of 143,500.- Euros per dwelling, which is a conservative estimate. Considering the income stream it has been assumed that the buildings will remain in ownership for twenty years and that the revenue on the income stream of these dwellings is about 14%. All other categories are for the simplicity of the exercise considered equal to the original data.

What can be ascertained from the newly derived balance sheet and profit and loss account (tables D3 & D4) is that the decision to lease the constructed dwellings instead of selling them has got some implications (numbers that have changed are shown in red, with the exact change mentioned after this number). First off all when it comes to the balance sheet, the solid assets of the company show a big growth as the constructed dwellings now have to remain on the balance sheet. As these assets now have to be financed, there is also an increase in both short- and long-term loans (in this exercise the decision was made to shelter the first 5 years of debt with short-term debt and the rest with long-term debt for liquidity reasons, which will become apparent later on in this explanation). As a result of this
<table>
<thead>
<tr>
<th>Vaste activa</th>
<th>Debet</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>immaterieel</td>
<td>2,8</td>
<td></td>
</tr>
<tr>
<td>materieel</td>
<td>52,5</td>
<td></td>
</tr>
<tr>
<td>financieel</td>
<td>23,1</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>78,1</td>
</tr>
<tr>
<td>Vlottende activa</td>
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<td></td>
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<tr>
<td>voorraden</td>
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<td></td>
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<tr>
<td>onderhanden</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>vorderingen</td>
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<td></td>
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<td>liquide middelen</td>
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<td></td>
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<td>Kortlopende schulden</td>
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<td>Saldo act. – lang en kort</td>
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<td>voorzieningen</td>
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<tr>
<td>Liquiditeit</td>
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<tr>
<td>Solvabiliteit</td>
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</tr>
</tbody>
</table>

Table D1: Balance sheet of a big Dutch construction company in the year 2013

<table>
<thead>
<tr>
<th>Winst-verliesrekening</th>
<th>Debet</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 (miljoenen €)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedrijfsoptrengsten</td>
<td>1033,3</td>
<td></td>
</tr>
<tr>
<td>Bedrijfskosten</td>
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<td></td>
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<tr>
<td>uitbested werk</td>
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<tr>
<td>lonen/salarissen</td>
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<tr>
<td>sociale lasten</td>
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<tr>
<td>afschrijvingen activa</td>
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<td></td>
</tr>
<tr>
<td>overig</td>
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<tr>
<td>Bedrijfsresultaat</td>
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<td></td>
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<tr>
<td>Financiële baten/lasten</td>
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<td></td>
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<td>rentebaten / lasten</td>
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<td>deelnemingen</td>
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<tr>
<td>Resultaat ante</td>
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<td></td>
</tr>
<tr>
<td>Resultaat post</td>
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<td></td>
</tr>
<tr>
<td>Nadere verdeling</td>
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<td></td>
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<tr>
<td>bedrijfsuitvoering</td>
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<tr>
<td>incidenteel</td>
<td>8,6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,5</td>
<td></td>
</tr>
</tbody>
</table>

Table D2: Profit and loss account of a big Dutch construction company in the year 2013
shift in income and debt, the liquidity and solvability of the company also alters, both show a weakening as opposed to the original setting, leaving especially the liquidity of the company below of what is considered to be a healthy ratio.

The profit and loss account shows equally big changes. Especially company income shows a lower figure as income from sales is now replaced by income from lease contracts, which eventually will pay out around the same amount but over a longer period of time. This is the main cause for the net-result of the company to turn very negative, as the income does no longer offset the costs that are made. Of course it can be argued that the costs should also be significantly lower, as no or little labour is needed for the continuing of the payments of the lease contract, however labour costs do not allow for a quick and sharp response to a changing situation (in a situation where people are fully employed by the company in question), it can therefore be argued that this change won’t offset the loss of income. Even if we would deduct the costs of delegated labour for the coming years, it would not offset the loss of income (this is not shown in the table but follows the reasoning of lowering the delegated labour category by 27%, leasing would then still imply a loss of around 50 million Euros, or 6% of company income). A buy-buy-back construction might offer better results here, but keep in mind that money would still need to be reserved each year in order to buy back the assets, this way of operating would therefore have more or less the same implications (only in the other way around) when it comes to the time period.

There are also some orange numbers present in table four, these refer to income and expenses that can be less accurately defined based on the data available, some remarks can however be made concerning these categories:

- Financial gains and losses from interest rates cannot be directly calculated based on data available in these tables. It can be argued however that the company will become more exposed to interest rate risk as a result of their growth in solid assets and long-term debt.
- The company result after taxes has been based on the assumption that all other activities of the company remain unchanged, this can however not be assured, and it can therefore not be said that this will be the actual result of the company moving into lease contracts, for this exercise however it remains a valid argument.

*Income from reselling at a later point in time*

One of the main thoughts behind CE is that the products that are being used can be reintroduced into the market with some alterations that make the product reach the standards that are needed at that point in time, eliminating waste as it were. What if the contractor from the example above would be able to reintroduce the product after a period of time at a relatively low cost? He would obviously save money as compared to having to start construction all over again (figure D3). This would mean an opportunity to the contractor’s business, however as seen in the example above leasing puts a lot of strain on the company’s balance and profit and loss account and it can be argued whether future savings can justify this strain, or whether the company might still be around to profit from this situation after a few years as it might not be able to cope with the pressure. The savings that can be made through this model would need to be big and preferably not to far ahead in time in order to be able to justify a leasing model on the basis of savings in the future.
<table>
<thead>
<tr>
<th>Vaste activa</th>
<th>Debet</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>immaterieel</td>
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<td></td>
</tr>
<tr>
<td>materieel</td>
<td>339,5</td>
<td>(+287)</td>
</tr>
<tr>
<td>financieel</td>
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<td></td>
</tr>
<tr>
<td></td>
<td><strong>365,4</strong></td>
<td>(+287)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Vlottende activa</th>
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<th>Credit</th>
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<tr>
<td>voorraden</td>
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<td></td>
</tr>
<tr>
<td>onderhanden</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>vorderingen</td>
<td>175,2</td>
<td></td>
</tr>
<tr>
<td>liquide middelen</td>
<td>97,1</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>364,1</strong></td>
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<table>
<thead>
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<th>Kortlopende schulden</th>
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<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>353,4</strong></td>
<td>(+57,5)</td>
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<table>
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<th>Langlopende schulden</th>
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<th>Credit</th>
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</thead>
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<table>
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<td>10,7</td>
<td>(-57,5)</td>
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<table>
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<th>Debet</th>
<th>Credit</th>
</tr>
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<td></td>
<td>156,6</td>
<td>(+10)</td>
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<table>
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<tr>
<th>voorzieningen</th>
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<table>
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<tr>
<td></td>
<td><strong>1,03</strong></td>
<td>(-0,2)</td>
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<table>
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<tr>
<th>Solvabiliteit</th>
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<th>Credit</th>
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<tbody>
<tr>
<td></td>
<td><strong>1,27</strong></td>
<td>(-0,2)</td>
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</table>

Table D3: Balance sheet of a big Dutch construction company in the year 2013 with circular building taken into account

<table>
<thead>
<tr>
<th>Winst-verliesrekening Circulair 2013 (miljoenen €)</th>
<th>Debet</th>
<th>Credit</th>
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</thead>
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<td>Bedrijfsopbrengsten</td>
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<th>Credit</th>
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<td>uitbested werk</td>
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<tr>
<td>lonen/salarissen</td>
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<tr>
<td>sociale lasten</td>
<td>36,8</td>
<td></td>
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<tr>
<td>afschrijvingen activa</td>
<td>9,9</td>
<td></td>
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<tr>
<td>overig</td>
<td>0,2</td>
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<th>Bedrijfsresultaat</th>
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<th>Credit</th>
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<td></td>
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<td>(-270)</td>
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<thead>
<tr>
<th>Financiële baten/lasten</th>
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<th>Credit</th>
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<td>rentebaten / lasten</td>
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<tr>
<td>deelnemingen</td>
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<th>Debet</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>277,6</strong></td>
<td>(-270)</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Debet</th>
<th>Credit</th>
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<tbody>
<tr>
<td></td>
<td>275,5</td>
<td>(-270)</td>
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<table>
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</thead>
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<tr>
<td>bedrijfsuitvoering</td>
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<td></td>
</tr>
<tr>
<td>incidenteel</td>
<td>8,6</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th></th>
<th>Debet</th>
<th>Credit</th>
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</thead>
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<tr>
<td></td>
<td>275,5</td>
<td></td>
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</tbody>
</table>

Table D4: Profit and loss account of a big Dutch construction company in the year 2013 with circular building taken into account
Figure D3: The chance to save money in the long run by reintroducing the product at a lower cost than constructing a new product (Own image).

Concluding remarks
Leasing the objects constructed instead of selling them in order to retain ownership does not make sense from a contractor’s current perspective. This exercise has shown that leasing impacts both the company’s liquidity and solvability in a negative way. It also causes a lot of deadweight capital in the form of solid assets on the company’s balance sheet. From the second year onwards, the company’s result would recover for the most part, however there would still remain a loss when compared to the selling strategy, this is mostly influenced by labour costs.

A buy-buy-back model would diminish the negative results at the start of the timeline, but would replace the negative effects to later stages in the timeline. This option does therefore not offer a viable way around the problems observed above.

Also reintroducing the product with low alteration costs at a later point in time becomes therefore difficult, as the leasing model puts a lot of strain on the company. The income and/or savings from reintroducing would therefore have to be of a considerable size in order to justify the leasing model.

D3 Building components in a circular construction industry
In order to get a grasp of what the effect of implementation of the circular economy in the construction industry might have on the relation between building components, this study will comprise a short research into what happens with building components in this situation. For the exercise below, buildings are described in terms of different components and reviewed from a circular point of view. Three situations are described: a building is composed of one component, ten components and hundred components. One central question will be asked: what does the situations mean for the potential success of the implementation of the circular economy theory.

The exercise
One component: The first situation describes an imaginative building composed of one component. Since it is only one component, there is no interconnection with other components. This makes the component easy to maintain and/or replace. Furthermore, a single component building also means that the building consists of only one lifespan. There is no need to create flexible connections.
Ten components: In this situation is building is composed of ten components. Here, some extra challenges emerge opposed to the previous situation. Ten components could mean different life spans. This means that some components need to be replaced where others are functionally still working. Here, the connectivity demands extra attention. Flexible connections have to be designed. On top of that, contractors have to replace components without compromising the functional and technical lifespan of the others. Furthermore there are judicial challenges. It is unclear what happens if the failure of one component affects the functioning of the other. A different issue next to flexibility is reachability. The more components there are, the more complex the construction is. A component has to be ‘reached’ easily in order to be able to maintain and/or replace it.

100 components: It is clear that in a building with 100 components the previous mentioned challenges are even bigger. It must be noted that in the current situation, this scenario is the most realistic in the construction industry. As buildings consisting of 100 components is more likely than buildings consisting of just one component.

Figure D4: Potential success of a circular building (Own image).

Concluding remarks
It could be concluded that the more components there are involved in a building, the more difficult it gets to implement the circular economy principle (figure D4, and table D5). With an increasing number of components significant organizational issues arise; all these components have to be maintained at different points in time. With this, also legal issues arise. For instance, it has to be clear who is responsible for the connections between components. Furthermore, contractors need to have knowledge of the connections with other components, preferably about the other component itself as well to make sure the maintenance process of one component does not compromise the functionality of the other. Concluding, flexible connections have to be designed keeping in mind the reachability issue as well (table D5 shows the main differences between the current and a (possible) circular situation).
<table>
<thead>
<tr>
<th>Current situation</th>
<th>Circular situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All components form one giant part, which is</td>
<td>All components form one giant part, which is</td>
</tr>
<tr>
<td>called a building</td>
<td>called a building</td>
</tr>
<tr>
<td>1 (or a few) owner(s)</td>
<td>Multiple owners</td>
</tr>
<tr>
<td>Solid connections</td>
<td>Flexible connections</td>
</tr>
<tr>
<td>Connections are not that important</td>
<td>Connections are paramount</td>
</tr>
<tr>
<td>It is the overall result that counts</td>
<td>Overall result is still important, internal</td>
</tr>
<tr>
<td></td>
<td>organization is however more important</td>
</tr>
</tbody>
</table>

Table D5: Comparison between a building that is being constructed according to present day convention and a building that is being constructed through a circular process (Own table).

**Concluding remarks exercises**

This section focused on three different short exercises that showed the practical implications of implementation of the circular economy in the construction industry. From these exercises it can be concluded that; when circular economy theory is brought to the ‘standard’ construction process, the division between owner and supplying party changes and becomes blurry. This complicates the process as supplying parties, contrary to the traditional ownership parties are subject to change throughout the process and there would therefore be a lot of different parties involved that can call themselves owners. It also affects the time scope of the involved parties. When it comes to business financing, it can be said that leasing the objects constructed instead of selling them in order to retain ownership does not make sense from a supplier’s current perspective. Leasing impacts both the company’s liquidity and solvability in a negative way. It also causes a lot of deadweight capital in the form of solid assets on the company’s balance sheet. From the second year onwards, the company’s result would recover for the most part, however there would still remain a loss when compared to the selling strategy. Other strategies like a buy-buy-back model or reintroducing a product were also found to be unlikely profitable activities. When it comes to building components (i.e. the products) a shift in demands will be needed when circular economy theory is implemented. Furthermore, the amount of individual building components plays a role in the feasibility of the circular economy in the construction industry, where the more components inherent in a building the less likely it seems that circular construction is feasible.
Appendix D: Comparison with general obstacles for the circular economy

*This appendix is co-authored by R. Stigter (contact details can be found in appendix A)

This section will make a comparison between the three exercises that were made and earlier research on obstacles for implementation of the circular economy. This earlier research however focuses on the implementation of the circular economy in general, it is not specifically done for the construction industry. In this way, this section will also make a comparison between the general obstacles and their relevance towards the construction industry. First off, an overview of the general obstacles that were found will be given, thereafter their connection to the three exercises will be made. This will then in turn give an overview of the obstacles that are relevant to the construction industry following the earlier made exercises.

The general obstacles for implementation of the circular economy

The obstacles that will be discussed in this section were found by Kok, Wurpel, and Ten Wolde (2013) in an attempt to create a roadmap towards the circular economy. These obstacles are considered to be general and valid for all actors that want to partake in the circular economy. It is important to stress that this list is not exhaustive, as is also acknowledged by the authors, and that the categories of the obstacles found are ‘loosely’ interpreted. All the obstacles can be found below in table E2, as clear as these obstacles are, their generality makes them abstract and hard to place in specific contexts without further context. This also means that the roadmap created by Kok, Wurpel, and Ten Wolde (2013) does not specify its steps in the depth needed to be directly applicable to certain industries, or as the authors call it: ‘a transition without a blueprint’. Tying the previously elaborated exercises to these obstacles should therefore make them operational and define the problem at hand in the construction industry, although it needs to be noted that like the list of obstacles, the exercises are also not exhaustive.

Validity of the list made by Kok et al. (2013)

Despite the arguments raised in the previous paragraph, the exercises are still tied to the roadmap made by Kok et al. (2013). It is logical to have some reservations to this comparison as a result of these arguments, however further research has shown that the list of obstacles named by Kok et al. (2013) is the most comprehensive (see table E1). In the left column the obstacles are given according to Kok et al. (2013). The columns to the right compares the obstacles found by Kok et al. (2013) to obstacles mentioned by other authors. It appears that the list made by Kok et al. (2013) is the most comprehensive list. The obstacles mentioned by respectively the Ellen MacArthur Foundation (2014), Preston (2012), De Grauw (2015) and Mentink (2014) do all recur in the selection of Kok et al. (2013).

Also other research (apart from the exercises) done by Loppies (2015) identifies six main challenges when the principles of the circular economy are translated to the construction industry. Based on six interviews with experts in the field he came up with:

1. Industrial, flexible and demountable designing
2. Materials are reusable or recyclable
3. Choice of materials should be socially responsible
4. New contract forms
5. Responsibility at the right parties
6. Materials need to be retrievable
Furthermore Loppies categorizes these challenges in:

1. Circular use of materials
2. Circular design
3. Safeguarding circularity for the future

If the six challenges of Loppies (2015) are compared to the obstacles of Kok et al. (2013) instead of Loppies’ own categories, it can be seen that the challenges show close relevance to some of the obstacles. Loppies’ first two challenges can be categorized as technological challenges, the third obstacle as societal, and challenges four, five, and six as organizational challenges. This shows that also through other research the main problems when translating the circular economy to the construction industry can be found at an organizational level, with also technological challenges. Financial issues are not present in this comparison, this was however not researched by Loppies (2015).

Because of the literature review that was done in this section the list made by Kok et al. (2013) is deemed valid for a comparison against the earlier made exercises.

Comparison between the exercises and the obstacles

In this section a comparison between the earlier made exercises and the above identified obstacles for implementation of the circular economy will be made. The comparisons will follow the same order as the one in which the exercises were introduced in this report, so first off is ownership in the circular construction industry, followed by business financing and concluded by the building components in the circular construction industry.

When comparing the ownership exercise with the above-identified obstacles, there appears to between the exercise and four different obstacles. First of all, the ownership exercise shows a connection with obstacle number two; externalities are not taken into account. This comes to the fore in the relatively short commitment of the supplying parties to the project, handing down responsibilities from one to another without remaining responsible throughout the entire project life span. There is also a link with obstacle number eleven; governance issues concerning responsibilities, liabilities and ownership. However this link is more at an organizational level than an institutional level in the construction industry, as the lines between the different supplying parties become blurry. There also appears to be a connection when it comes to the limited attention for the end-of-life phase in current product designs (obstacle nr. 11), following the same reasoning as stated above in connection with obstacle number two. Which also holds true for the last obstacle to be tied to this exercise, obstacle number 22; linear technologies are deeply rooted.

The business finance exercise shows a connection with obstacle number one; major-upfront investment costs, mainly due to the shift in income streams. Also obstacle number three; shareholders with a short-term agenda dominate corporate governance holds true, albeit in a slightly different context. As the exercise does not say anything about corporate shareholders there can be no link on this point, the exercise however did show that there is some logic in shifting responsibilities to a party with a longer commitment to the project. Furthermore there is a connection with obstacles number eleven, nineteen, and 22 on the same grounds as in the ownership exercise.

The third exercise looked at building components (i.e.) the products in a circular construction industry, here too links were found between the exercise and obstacles eleven, and nineteen. In this exercise however, also obstacle number fifteen; exchange of materials is limited by capacity of reverse logistics, comes into play. This is because of the complex sum of parts a building is, it will therefore be difficult to divide all the individual components
neatly and get them back to their manufacturers (owners). For this reason there is also a link with obstacles twenty and twenty-one.

<table>
<thead>
<tr>
<th>Financial</th>
<th>Institutional</th>
<th>Infrastructural</th>
<th>Societal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Major up-front investment costs</td>
<td>6. Unlevel playing field created by current institutions</td>
<td>12. Limited application of new business models</td>
<td>16. Lack of awareness and sense of urgency, also in businesses</td>
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<tr>
<td>2. Externalities are not taken into account</td>
<td>7. Financial government incentives support the linear economy</td>
<td>13. Lack of an information exchange system</td>
<td>17. GDP does not show the real progress or decline of our society</td>
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<tr>
<td>4. Recycled materials are often still more expensive than virgin materials</td>
<td>9. Competition legislation inhibits collaboration between companies</td>
<td>15. Exchange of materials is limited by capacity of reverse logistics</td>
<td>7. Lack of consumer enthusiasm</td>
</tr>
<tr>
<td>5. Higher costs for management and planning</td>
<td>10. Recycling policies are ineffective to obtain high quality recycling</td>
<td></td>
<td>6. The innovation challenge (information)</td>
</tr>
<tr>
<td></td>
<td>11. Governance issues concerning responsibilities, liabilities and ownership</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>Institutional</td>
<td>Infrastructural</td>
<td>Societal</td>
</tr>
<tr>
<td>1. Higher capital or cash required to change existing product design.</td>
<td>3. Imperfect design at the beginning of supply chain if the profits from a better design would only occur at the end-of-use phase</td>
<td>6. The innovation challenge (information)</td>
<td>16. Overcome the current linear business logic</td>
</tr>
<tr>
<td>2. Customers only evaluate purchase price instead of NPV of a product.</td>
<td>4. Transnational authorities and lack of national collaboration</td>
<td></td>
<td>17. Master increased complexity</td>
</tr>
<tr>
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<td>2. Lack of competences</td>
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Table E1: Comparison of the list of obstacles made by Kok et al. (2013) with various other authors (own table)

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<td>Infrastructure</td>
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Table E2: Overview of general obstacles to be found for actors when implementing the circular economy (source: Kok et al., 2013)
Concluding remarks comparison

When comparing the exercises with the obstacles provided by Kok, Wurpel, and Ten Wolde (2013), it becomes clear that the problems surrounding the implementation of the circular economy reside along the categories ‘financial’ and ‘technological’ with almost all of the connections to be found in these categories. The biggest match however, is made between the institutional obstacle; governance issues concerning responsibilities, liabilities, and ownership. In the context of the construction industry however it would be more fitting to talk about an organizational obstacle at the level of the individual actors amongst themselves.
Appendix E: Circular construction industry vs. PBB

This appendix makes a comparison between a circular construction industry and performance-based building. This is done in order to clarify the differences between the two concepts, as they appear to have some similarities that might create confusion. And while this appendix shows that there is some relation between the two concepts, there are also some differences to be noted.

Performance-based building

Performance-based building is a concept that takes a look at building from a different viewpoint as usual. This becomes clear when looking at the definition:

‘Performance-based building is concerned with what a building or building product is required to do, rather than prescribing how it is to be constructed (Sexton & Barret, 2005)’

The current convention in the construction industry focuses on this prescription, therefore performance-based building offers a radically different approach to the construction industry (see chapter 3.1 & 3.2; De Ridder, 2013). Its stance is that the traditional approach in the construction industry blocks innovation as parties are unable to appropriate possible advantages from innovation to themselves because of the constraining environment. It is therefore less likely that innovation will occur in the construction industry (Sexton & Barret, 2005).

Similarities between PBB and a circular construction industry

Without further restrictions on the definition of performance-based building, it can be assumed that actors have the capacity, ability, and motivation to innovate from a business perspective. This as it is unable to evaluate performance-based building without its business logic (Sexton & Barret, 2005). This bears a resemblance to the circular business model prototypes as developed in this report where it is assumed that the amount of capabilities (and knowledge thereof) within the organization of the service provider determine the size of a possible organizational stretch and its suitability as a service provider. Next to that, as was explained with respect to the circular economy, also with performance-based building it remains, as of yet, unclear what a general, appropriate level of service provision is (Sexton & Barret, 2005). Furthermore this report investigates the circular economy from its business logic as it was explained in chapter one that this is the main focus of the circular economy.

Another similarity between the two concepts is that, as with the circular economy, performance-based building should be ‘embodied’ by the organization. If the concept is used as an add-on, it will not function as effectively (Sexton & Barret, 2005).

Also, a similarity can be found in the interplay between client and supplier. This report showed that coordination between the client and the service provider in the circular economy should enable the delivery of the optimal performance. With performance-based building acknowledgement is given to the fact that results will be better when both parties are involved in designing the solution (Sexton & Barret, 2005).

The last similarity can be found in the fact that both concepts revolve around a supplier delivering a performance to a client.

Differences between PBB and a circular construction industry

The first difference between performance-based building and the construction industry can be found in the definition of performance-based building. While it is acknowledged in the
business model prototypes that ‘the performance should not be too specified by the client’, circular economy does indeed prescribe certain solutions. Because the circular economy, while focusing on performances, does prescribe (in case of base- to intermediate services) what needs to be done with the products in order for them to fit to the circular economic concept. Performance-based building does not prescribe any restrictions on the possible solutions, in fact this is at the heart of its innovative nature.

In case of advanced services, the circular economic concept also prescribes ‘a correct solution’ through the financial incentive that is present in the system. This entails that the service provider needs to retain ownership over its products. Performance-based building does not make this prescription.

Thirdly (and this might be a temporary difference), current, successful applications of performance-based building are centred in the maintenance sector of the construction industry. Research done by Straub (2011) shows that maintenance providers are taking on work previously carried out by contractors under the influence of performance-based building. However the focus here is on maintenance (and operate), and does not include a whole building project from the beginning to the end.

Concluding remarks
There are similarities in the approach of both concepts, leading to the same focus on some parts of both concepts. However performance-based building focuses solely on the output (i.e. the requested performance), while the circular economy shifts more to input when it comes to base- and intermediate services. Furthermore, for advanced services circular economy prescribes modes of ownership, this aspect is also not present in performance-based building.
Appendix F: Case study: Interior design of the TenneT Centre of excellence

Figure F1: Pictures of the interior of the TenneT headquarters (Source: Bijsterveld, 2014)

Aim of the case study
The TenneT-project proclaims to have sorted out issues surrounding manufacturers taking back their products at the end of their lifetime. This case study’s main goal is therefore inquiring in what manner this has been arranged, also the concept of circular economy will be offset against the definition and preconditions as provided by this report.

Contents of this case study
Project characteristics, General project description, Product take-back, The parties that took part in the project, General circular economic concept, Other remarks, Concluding remarks

Project characteristics
Client(s): TenneT TSO
Location: Mariëndaal Centre of Excellence
          Utrechtseweg 310, Arnhem
Size: 24.000 m2 GFA
Delivery: July 2013
Supplying parties: Studio Groen+Schild, Hoogendoorn MBI, Boerhof projectinrichters, Rendemint, draaijer+partners, Ahrend, Shaw, Luceplan, QC Lightfactory, Etap, Intermontage B.V., Bouwcombinatie BAM-Giesbers

General project description
TenneT as a company is responsible for the maintenance of the Dutch (and part of the German) electricity network. TenneT needed a centre of excellence as it was growing considerably and quite rapidly, within this project there was an ambition to realize the interior of the building (non-bearing walls, office furniture, and floor and ceiling covering) with an as-high-as-possible cradle-to-cradle ranking (Bijsterveld, 2014). This ambition originated from the project manager (Appendix T1), and was for a large part realized through the use of Pre-Returnable-Procurement® (PRP) contracts. This contract states, even before placement in the project, of what materials the products are made and to what degree it is possible to recycle these products. The specifics of this type of contract will be described below in the section ‘product take-back’.
Product take-back

The PRP-contracts that were used in the TenneT case were delivered by a sustainable consultancy firm, in order to get a more detailed view on how these contracts function an interview with that consultancy firm was conducted (Appendix T1). This revealed the process as it is described in this section.

PRP-contracts work on the basis of an overview of all materials that are being used in a product, this overview will be checked through audits on a regular basis. Through this procedure the amount of material and quality thereof (no toxic materials, glue, unnecessary plastics etc.) used in products and subsequently buildings can be checked and controlled. Parties responsible for delivering these products commit themselves to these values and their correctness. In this way it becomes possible to create an overview of what amount of a certain building can be down-, recycled, or re-used after the contract term ends. This contract term is set by the client, and was in this particular case set at 15 years (due to the term of depreciation). During these 15 years the client remains responsible for the maintenance of the delivered products (although in a lease contract this might be different).

If during maintenance new material might be needed in order to guarantee the performance of a certain product, these materials need to be registered as well through a ‘mutation-form’. This is done in order to keep continuous track of the materials that are being used in the products and building (this use of this form is not obligatory in the TenneT-case). After these 15 years the suppliers are obligated through the contract to take their products back, although the client may also try to sell them in the aftermarket to other parties first. The party that claims the products after 15 years, whether it is the original client, an original supplying party, or a third party, is legally bound by the contract to treat the products in the manner that was stated in the PRP-contract (recycle, re-use, etc.). As circumstances might have changed in 15 years (e.g. technological improvements) another audit will be performed at that time in order to check what can be done with the products at that point in time.

Therefore in short it can be said that PRP-contracts work on the basis of an overview of all materials that are being used in a product, this overview will be checked through audits on a regular basis. Through this procedure the amount of material and quality thereof (no toxic materials, glue, unnecessary plastics etc.) used in products and subsequently buildings can be checked and controlled during the entire time of the contract. Possible third parties that might be added in the 15-year term will also be held to the same conditions.

The parties that took part in the project

As it turns out there were particular parties that took part in the project, this section will elaborate on those parties and their roles and responsibilities in the project, as well as other points of attention (the information in this section is obtained through the interview with the sustainable consultancy firm added to this report as appendix T1).

In this case the demand side is represented by TenneT as the client. Although the client had sustainable ambitions, the idea of implementing circular economy in this project was a proposition made by the project manager. This has led to a building that is ultimately more sustainable than at first aimed for by the client. This although the client could only affect the interior design, as the building is owned by a third party and already existed. This stresses the importance of having a client that is willing to think and be flexible when it comes to sustainable ambitions.

The tender for a circular building (the client had to comply to European regulations and was therefore required to tender the building) mainly attracted supplying parties that believed in
this way of tendering. In general it can be said that three different groups of supplying parties could be identified with this particular tender. First, parties that do not believe in sustainable tendering and therefore do not comply with the demands asked of their products (no toxic materials, glue, unnecessary plastics etc.). Second, parties that want to partake in the project in a sustainable way and want to meet the demands but do not know how to achieve this. Third, parties that already know how to deal with these sustainable demands and comply with the questions asked. The eventual parties that were selected through the tender were committed to the project and its sustainable ambitions (this might partly be the case because this was enforced through the PRP-contract). Examples of this commitment can be found in the fact that some of these parties changed the resources that are needed in their products and banned plastic wrapping throughout the project (instead they came up with new, re-useable wrapping material). This shows the importance of having committed supplying parties involved in a project, and making sure they are actually committed, as it can clearly deliver results.

This section showed the importance of having a client that is willing to think and be flexible when it comes to sustainable ambitions. On the other hand it is also important to have committed supplying parties involved in a project, and to make sure they are actually committed, as it can clearly deliver results.

General circular economic concept
The concept of circular economy present during this project focuses on the circularity of products, which is verified through PRP-contracts. There is no focus on a long-term (financial) incentive for the supplying parties, this is might be because the project started out from a cradle-to-cradle point of view. The sustainable consultancy firm has got a very specific view on the circular economy. This view is elaborated in Appendix in an interview that is available in appendix T1.

Other remarks
This section features some general remarks that can be made about the Tennet-case and originate from the interview with the sustainable consultancy firm (appendix T1).

- PRP-contracts up to now mainly stress the degree of non-circularity of a product. It is therefore a sign of the fact that circularity is still in its infancy.
- With regard to the third parties that might buy the products after the 15-year contract term; it is the belief of the sustainable consultancy firm that the influence of the circular economy will give rise to ‘urban-mining brokers’.
- A weakness in the current PRP-contract system is that although the involved parties are legally bound to proper treatment of the involved products and materials, it could still happen that this will not be followed through. In a situation where, after the 15-year contract term has ended, not a single party is interested in claiming the products, they can be disposed of without further consequences (although it actually is a breach of contract, it is with mutual understanding).

Concluding remarks
TenneT needed a centre of excellence as it was growing considerably and quite rapidly, within this project there was an ambition to realize the interior of the building (non-bearing walls, office furniture, and floor and ceiling covering) with an as-high-as-possible cradle-to-cradle ranking (Bijsterveld, 2014). This ambition originated from the project manager (Appendix T1), and was for a large part realized through the use of Pre-Returnable-Procurement® (PRP) contract. PRP-contracts work on the basis of an overview of all
materials that are being used in a product, this overview will be checked through audits on a regular basis. Through this procedure the amount of material and quality thereof (no toxic materials, glue, unnecessary plastics etc.) used in products and subsequently buildings can be checked and controlled during the entire time of the contract. Possible third parties that might be added in the 15-year term will also be held to the same conditions. Although the involved parties are legally bounded to proper treatment of the involved products and materials, it could still happen that this will not be followed through. In a situation, where after the 15-year contract term has ended, not a single party is interested in claiming the products, they can be disposed of without further consequences (although it actually is a breach of contract, it is with mutual understanding). This case therefore showed the importance of having a client that is willing to think and be flexible when it comes to sustainable ambitions. On the other hand it is also important to have committed supplying parties involved in a project, and to make sure they are actually committed, as it clearly can deliver high-quality results.
Appendix G: Case study: Desso

Figure G1: Desso company logo (Source: Desso, 2013)

Aim of the case study
Desso operates its business in a cradle-to-cradle fashion and has ambitions to take part in the circular economy. This case study’s main goal is therefore inquiring in what manner this has been arranged, also the concept of circular economy will be offset against the definition and preconditions as provided by this report.

Contents of this case study
Company description, Why is Desso currently operating in a circular or c2c fashion?, How does Desso operate in a circular or c2c fashion?, General circular economic concept,
In what kind of industry is Desso present?

Company characteristics
Name: Desso B.V.
Address: Postbus 169
9140 AD Waalwijk
Size (turnover): €202 mln (2013)
Products: Office carpet (tiles)
Supplying parties: Auqafil (special string)

General company description
Desso manufactures carpet tiles and wants to make these in an environmentally friendly way. That is one of the reasons that Desso embraced the cradle-to-cradle concept in 2008. Through using this concept and the vision behind it, Desso wants to become the market leader in sustainable floor products. Desso is already active in most parts of the world and provides floor solutions in business sectors as: education, healthcare, offices, homes, sports, hospitality, marine and aviation industry (Desso, 2013).

Why is Desso currently operating in a cradle-to-cradle fashion?
Desso has embraced the cradle-to-cradle concept as one of the three pillars of its innovation strategy, the other two being creativity, and functionality (Desso, 2014a). Desso wants each product it makes to adhere to these three pillars in order to be able to deliver: ‘floor solutions that contribute to our health and well-being’ (Desso, 2014b). In this way, embracing the cradle-to-cradle concept is part of Desso’s business strategy. In others words Desso sees cradle-to-cradle as a way to set itself apart from the competition.

How does Desso operate in a cradle-to-cradle fashion?
Figure G2 shows the technical cycle of Desso’s carpet products, and at the same way the basis of their cradle-to-cradle operations. It is worth noting though, that Desso also takes in products from other manufacturers and inserts them into Desso’s own technical cycle. In this way Desso also captures business from other manufacturers. When carpet is returned to Desso, it is taken apart in three main components that receive further treatment and are then re-used in another product. This new product is then laid out at a customer site again,
when the customer wants something new, or the carpet is worn out, Desso can take it back and start the cycle again.

Desso does not obligate parties to return the carpet to Desso again after use, it merely sells it and gives the customer this option. As a matter of fact, Desso actually gets paid to remove the carpet again (Desso, 2013).

In order to be able to guarantee the quality of its products, Desso holds its suppliers under a very tight lens. Suppliers need to be registered at two different institutions that check both the ethics of the supplier as well as the quality and origin of the materials the supplier uses. Both these facts are audited by the aforementioned institutions on a regular basis, if a supplier does not comply with the imposed standards, Desso will no longer deal with said supplier (Desso, 2015).

As stated in this cases study’s introduction, Desso has ambitions regarding the circular economy. Since Desso has integrated cradle-to-cradle into the core of its operations, it sees possibilities for implementing the circular economy in these operations too. One of the first manifestations of these ambitions comes from the option to lease Desso’s carpet products. In order to be able to offer this service, Desso has teamed up with a finance company that specializes in lease-solutions (Desso, 2014b). Along with the lease, Desso wants to offer various other services like: laying the carpet, maintenance, cleaning, and removing it after its lifetime.

**General circular economic concept**
Desso’s circular economic concept follows that as it was introduced by the EllenMacArthur Foundation, in the way that Desso follows the foundation’s reasoning surrounding resource prices etc. Desso does recognize that different constructions are needed in a circular economy, which becomes apparent to the lease-construction as it was described above. For clients that don’t want to use this service however, it remains unclear how Desso will ensure a circular economy. Furthermore its current cradle-to-cradle concept is, however well...
implemented, not circular. This is because there is no guarantee that the products will be taken back (effectively) at the end of their life-time.

**In what kind of industry is Desso present?**
Desso is present in an industry that has not shown a lot of innovation over the years, therefore Desso is able to market itself effectively as being different from the rest with its cradle-to-cradle operations. Furthermore carpet-tiles are a general (modular) product, that are not dependent upon a specific context. Of course Desso shows different kinds of products for different industries (Desso, 2014b), but apart from these broad segments there is not a lot of differentiation in between the products.

**Concluding remarks**
Desso has embraced the cradle-to-cradle concept as one of the three pillars of its innovation strategy, the other two being creativity, and functionality. In this way, embracing the cradle-to-cradle concept is part of Desso’s business strategy. In order to be able to deliver on its sustainability claims, Desso monitors its suppliers closely. Although Desso has got some circular economic ambitions, its current product base is not circular as there is no guarantee that the products will be taken back (effectively) at the end of their life-time.
Appendix H: Case study: Vanderlande

Aim of the case study
Vanderlande operates its business in a sustainable fashion with a focus on people, planet, and profit, and has ambitions to take part in the circular economy. This case study’s main goal is therefore inquiring in what manner this has been arranged. Next to that also the concept of circular economy will be offset against the definition and preconditions as provided by this report.

Contents of this case study
Company description, Why is Vanderlande currently operating in a circular or sustainable fashion?, How does Vanderlande operate in a circular or sustainable fashion?, General circular economic concept, In what kind of industry is Vanderlande present?

Company characteristics
Name: Vanderlande
Address: Vanderlandelaan 2
5466 RB Veghel
Products: Baggage- / Package-handling systems
Supplying parties: -

General company description
Vanderlande is responsible for the manufacturing of baggage-, and package-handling systems at airports and warehouses around the world. Established in 1949, Vanderlande’s systems now move 3.2 billion pieces of luggage around the world every year. Also 20 million packages find their way through Vanderlande’s systems every day (Vanderlande, 2015a).

Why is Vanderlande currently operating in a sustainable fashion?
Vanderlande’s focus on sustainability is focused upon people, planet, and profit (Vanderlande, 2015b). Therefore its sustainability concept is a bit less conceptualized through methods like cradle-to-cradle, and focused more on concrete, direct results within the organization. Among other things, Vanderlande views sustainability as a way to keep up with the cutting edge in its field of operations and therefore finds it an important factor (Vanderlande, 2015b).

How does Vanderlande operate in a sustainable fashion?
As of yet, Vanderlande’s focus has been mostly about minimizing its own footprint. In order to do so, it has for instance written a code of conduct for its suppliers (Vanderlande, 2015b). Within this code of conduct Vanderlande prescribes its suppliers on how to deal with their products in order for Vanderlande to be able to tell with certainty that its resources are derived in a sustainable way.

There is, as of yet, not a clear circular product to be found at Vanderlande (despite of its circular ambitions), however interestingly Vanderlande is involved in a lot of system optimizing already. It does this in order to be able to deliver services coupled to its baggage-, and package-systems. These systems come with an array of possible services like pre-
emptive maintenance, scheduled maintenance, corrective maintenance, work scheduling (in order to use the system most effectively), lifecycle-plans for a particular system, business model consultancy, pay-per-use models, and financial services (Vanderlande, 2015c; Vanderlande, 2015d). Vanderlande’s reasoning is that with its expansive knowledge of its systems it is capable of delivering these services effectively towards the customer. This is a similar kind of reasoning as could be found in the research of Baines and Lightfoot (2013), interestingly also similar to that research Vanderlande has not got a clear sustainability goal with these services, they are simply part of Vanderlande’s business operations.

Vanderlande has however designed a cradle-to-cradle warehouse system that allows for complete disassembly and reverse logistics at the end of the product lifetime. In order to make this system more efficient, Vanderlande has redesigned some part of the system completely by itself (Vanderlande, 2015b). This is also in concurrence with the findings of Baines and Lightfoot (2013) and exemplary of the ‘different than usual operations’ needed by companies in order to be able to deliver services efficiently.

*General circular economic concept*

Vanderlande does, as of yet, not have a clear circular economic concept or product, it has merely touched upon the subject (Vanderlande, 2015b). Therefore the only circular motivation present reflects the reasoning as it can be found in reports by the EllenMacArthur Foundation. Despite of the lack of concrete examples at Vanderlande, from an organizational point of view the company shows great potential to develop a circular business (as can be seen from the previous section of this case study).

*In what kind of industry is Vanderlande present?*

Vanderlande is present in a worldwide industry of complex technical products. Within this industry Vanderlande is now offering services based on its deployed products (systems), these services are responsible for 18% of total revenue made by Vanderlande (Vanderlande, 2015b). The products offered by Vanderlande are generic, with slight differences and specialties for each location in order to be able to deliver the best performance at a specific site.

*Concluding remarks*

Vanderlande’s focus on sustainability is focused upon people, planet, and profit. Therefore its sustainability concept is a bit less conceptualized through methods like cradle-to-cradle, and focused more on concrete, direct results within the organization. Interestingly though, Vanderlande is involved in a lot of system optimizing already. It does this in order to be able to deliver services coupled to its baggage-, and package-systems. Vanderlande’s reasoning is that with its expansive knowledge of its systems it is capable of delivering these services effectively towards the customer.

Vanderlande does, as of yet, not have a clear circular economic concept or product, it has merely touched upon the subject. Despite of the lack of concrete examples at Vanderlande, from an organizational point of view the company shows great potential to develop a circular business. The products offered by Vanderlande are generic, with slight differences and specialties for each location in order to be able to deliver the best performance at a specific site.
Appendix I: Case study: BMA Ergonomics

*This case study is co-authored by R. Stigter (contact details can be found in appendix A)

Aim of the case study
BMA Ergonomics (hereafter BMA) proclaims to operate its business in a circular way. This case study’s main goal is therefore inquiring in what manner this has been arranged, also the concept of circular economy will be offset against the definition and preconditions as provided by this report.

Contents of this case study
Company description, Why is BMA currently operating in a circular or sustainable fashion?, How does BMA operate in a circular or sustainable fashion?, General circular economic concept, In what kind of industry is BMA present?, Interview product manager (appendix T2)

Company characteristics
Name: BMA Ergonomics
Address: Schoenerweg 4
8042 PJ Zwolle
Size (turnover): Unknown
Products: Office chairs
Supplying parties: (amongst others) Timmerije B.V.

General company description
BMA is a manufacturer of office chairs, and is active in The Netherlands, Belgium, and Germany. Besides focusing on creating circular products, BMA also focuses on a sustainable workforce, thereby creating an all-round concept.

Why is BMA currently operating in a circular fashion?
BMA experiences that its customers demand sustainable products, and are willing to invest in these sustainable products even in periods of a weakening economy (BMA, 2015a). Furthermore, BMA acknowledges the impact it has on resources as a manufacturer and wants to minimize its impact on those resources (BMA, 2015a). Next to these reasons, BMA views circular products as complementary to their vision on a sustainable workforce (appendix T2).

How does BMA operate in a circular fashion?
The best way to understand the circular loop BMA has created for its products is to look at figure I2. In figure I2 it becomes clear that during production BMA focuses on the use of materials, the lifetime of the product and the coupled CO2 emissions inherent to these processes. These are activities that take place at BMA internally, externally BMA engages in a dialogue and audits with its suppliers (appendix T2). Only if suppliers operate within the demands imposed by BMA are they allowed to supply the company (this is because BMA
sees itself as the chain’s focal company (BMA, 2015a; appendix T2)). When the product is finished, it is deployed at the client’s site of operations. When the chairs no longer live up to the clients expectations, they can be returned to BMA where they will take part in the so-called ‘revitalization programme’ (see figure I3). For returning the chairs, the client receives a sum of money that was paid upfront with the acquisition of the chairs in return (Appendix T2). Once the chairs are returned to BMA, BMA tries to ‘revitalize’ the chairs if this turns out (for whatever reason) not to be possible, original materials are returned to BMA’s suppliers (BMA, 2015a).

Figure I2: lifecycle of BMA’s Axia chair (Source: BMA, 2015b)
General circular economic concept
BMA’s products originate from a cradle-to-cradle school of thought, which can be seen from the cradle-to-cradle certification that is attached to its products. When venturing into the circular economy, BMA has started to offer buyback-guarantees with its sales (appendix T2). These guarantees obligate BMA to buy its delivered products back at the end of their lifetime. This ensures that the financial incentive is present at BMA in order to re-vitalize or re-design the used chairs.

In what kind of industry is BMA present?
The office chair market is substantive in size (every office needs office chairs) and generic. Companies can specialize in creating the most ergonomic chair for instance, but there will still be a lot of other manufacturers present with a similar kind of offer. BMA has recognized that sustainability can add to the sales-potential of its products (BMA, 2015a; appendix T2), therefore operating in a circular way offers BMA a way to stand out over other manufacturers.

Concluding remarks
BMA experiences that its customers demand sustainable products, and are willing to invest in these sustainable products even in periods of a weakening economy. During production BMA focuses on the use of materials, the lifetime of the product and the coupled CO2 emissions inherent to these processes. These are activities that take place at BMA internally, externally BMA engages in a dialogue and audits with its suppliers. When venturing into the circular economy, BMA has started to offer buyback-guarantees with its sales. These guarantees obligate BMA to buy its delivered products back at the end of their lifetime.
Appendix J: Case study: Iewan

Figure J1: The Iewan apartment-complex (Iewan, 2016)

Aim of the case study
Iewan is a sustainable apartment-complex that has been recently developed. It was brought forward by one of the interviewees of this research as an important part of their activities. This case study’s main goal is therefore inquiring what the concept is about, also the matter of circularity of the project will be offset against the circular service level framework and circular business model prototypes as provided by this report.

Contents of this case study
Project description, How is circularity realized in this project?, Relation between the project and the circular service level framework and circular business model prototypes.

Project characteristics
Name: Iewan
Address: Karl Marxstraat 101
         Lent
Size (m²): ±2500 m²
Delivery: 2014
Supplying parties: a.o. Talis, Orio architecten, Vastbouw

General project description
Iewan is a housing project that uses hay as its main construction material. The project was initiated by a group of citizens that had a joint housing ambition. Their goal was to create a sustainable housing complex with a couple of ambitions set out by themselves. The main ambition was to create an ecological building complex, further clarifications, like a programme of requirements were not given (Appendix T3). A look has for instance been given towards the eradication of concrete throughout the project, but also aspects like the water supply needed to be organized in a sustainable way.

How is circularity realized in this project?
This project has not been undertaken from a circular economic concept, its main goal was to achieve completely ecological housing (Appendix T3). Circularity has therefore also not been realized, however there are some aspects of the project that show some similarities with other cases and literature that was presented in this research.
Throughout the construction process for instance there has been a constant check of the materials that could be used in the project. If materials did not meet the ecological standards as set out by the community, it would not be used in the construction of the apartment-complex (Appendix T3).

Secondly, it was the community that decided that posed a question towards the supplying parties and did not specify it any further than that the building complex needed to be ecological (Appendix T3). This provided clear boundaries for the supplying parties, but not necessarily a fixed set of solutions. This corresponds to one of the circular needs posed by section 6.1, where it was stated that the solution should not be too specified by the client.

Thirdly, the demands posed by the community prompted a new way of financing. Since there were some unorthodox aspects to the proposal of the community, like building with hay, it was difficult to obtain financing. A housing association that believed in the project therefore acted as a financier towards this project (Appendix T3).

How does this project relate to the circular service level framework and the circular business model prototypes?
Currently iewan cannot be compared directly to the circular service level or the business model prototypes. This because the project has not been realized from a circular point of view, and it also does not adhere to the definition of a circular building as maintained in this research.

![Diagram](image)

**Figure J2:** The position of iewan in the circular service level framework if the project would adhere to the circular requirements posed in this research (own image).

However, the project has shown conscious, ecological material choices throughout the project. If it would be ensured that these materials are redeployed in another loop, this would be relatively easy as they are ecological materials, the project would meet the requirements for basic circular services (see figure J2).

**Concluding remarks**
iewan is not circular because no thought has been given to an end-of-life situation, although use is made of ecological materials. iewan does show affinity with some of the proposed requirements for the proper functioning of a circular construction industry as they were outlined in section 6.1. In particular the fact that roles of actors might need to change and the fact that the question formulated by the client should not be too specified are apparent in the project.
Appendix K: Case study: Growing Green

Aim of the case study
Growing Green is a sustainable module that has been recently developed. It was brought forward by one of the interviewees of this research as an important part of their activities. This case study’s main goal is therefore inquiring what the concept is about, also the matter of circularity of the project will be offset against the circular service level framework and circular business model prototypes as provided by this report.

Contents of this case study
Project description, How is circularity realized in this project?, Relation between the project and the circular service level framework and circular business model prototypes.

Project characteristics
Name: Growing Green
Address: Meermanstraat
Delft (Showcase)
Size (m2): 100 - X m2
Delivery: 2015
Supplying parties: Smits Vastgoedzorg, PPG Industrial Coatings, Verweij Houttechniek, Nieuwe Architecten, Feenstra, NPSP

General project description
A consortium of supplying parties has developed a renovation concept that makes it possible to sustainably renovate one or more dwellings in an apartment building. This can be done at the same time or over a certain time-period. With the appliance of this concept a housing association (the target group of the concept) is able to sustainably renovate its assets gradually and to prolong the lifetime of its dwellings for another 50 years.

Therefore the concept makes use of a new façade structure that is placed instead of the old structure, and new installations that provide heating and/or cooling in the dwelling (see figure K2).
How is circularity realized in this project?
This project has not been started out from a circular concept, also not from a cradle-to-cradle concept or any sustainable concept alike (Appendix T4). Circularity has therefore also not been realized, however there are some aspects of the project that show some similarities with other cases and literature that was presented in this research.

The sustainability aspect in this project seems to stem from lower energy-costs for the user as a result of the implementation of the Growing Green concept and a higher real estate value for the owner (Growing Green, 2016). Interestingly though, some thought has also been given to material choices in the concept. For instance the windowpanes are made up out of sustainably sourced wood and constructed without glue (Appendix T4). Any incentive for this choice can however not be found.

The consortium simply delivers a product with this concept without any related services, apart from a detailed account of the to be expected performance and maintenance of the concept (Appendix T4). For research purposes however, the consortium does monitor the condition of the dwelling and its installations (Appendix T4). Through combining this with section 5.2 of this research it can be seen that a service like maintenance for a certain period of time could be added relatively easily to the Growing Green concept.

How does this project relate to the circular service level framework and the circular business model prototypes?
Currently there are no services linked to the Growing Green concept, however the last section has shown that through the monitoring of the dwelling, a service as for instance maintenance could be added relatively easily to the concept. If this last step were to be implemented, the concept would lend itself to intermediate circular services. For this to be realized completely however, it would need to be made sure that all of the used materials are picked as consciously as the windowpanes. If these aspects were to be implemented correctly, Growing Green would qualify for base- to intermediate circular services (figure K3).
Since the Growing Green concept is not circular, it cannot be compared directly to the developed circular business model prototypes. However this sustainable concept would not have been able to be realized without the consortium of supplying parties, with each actor delivering key information on their specific fields (Appendix T4). Although there is certainly not a direct link, also both variants 3 and 5 could be realized through consortia in a similar way (albeit with different operational responsibilities).

Concluding remarks
The Growing Green concept is not circular in any way and its sustainable origins stem from energetic and real estate value gains. This makes a direct comparison between the concept and the circular service framework and the prototypes impossible. However, some aspects of the concept were found to enhance the circularity enhancing, and with the right focus Growing Green could be a base- to intermediate circular solution.
Appendix L: Case study: Heijmans One

Aim of the case study
Heijmans One is a movable module that has been recently developed. It was brought forward by one of the interviewees of this research as an important part of their activities. This case study’s main goal is therefore inquiring what the concept is about, also the matter of circularity of the project will be offset against the circular service level framework and circular business model prototypes as provided by this report.

Contents of this case study
Project description, How is circularity realized in this project?, Relation between the project and the circular service level framework and circular business model prototypes.

Project characteristics
Name: Heijmans One
Address: Movable units
Size (m2): 50 m2
Delivery: 2014
Supplying parties: Heijmans, Mood Architecture

General project description
Heijmans One was developed as a modular, movable one-person-household home. The main construction exists of either one or two shipping containers, that when they are combined, form a one-person home. The goal was to create this home with all the necessary amenities in place. Therefore the Heijmans One consists of a bathroom, kitchen, living-, and bedroom (Heijmans, 2014).

The concept was realised in order to answer to a demand posed by the market for temporary functions (Appendix T6). These temporary functions can be placed in areas that are awaiting development, but for some reason this development will not take place in the
foreseeable future (the developer of the concept refers to this as pause-landscapes) (Heijmans, 2014). With this temporary aspect in mind, the Heijmans One is designed to be a movable, modular home. After the need for the concept at a particular location has disappeared, it can easily be redeployed at other sites again without further alterations (Appendix T6).

**How is circularity realized in this project?**
This project has not been developed from a circular point of view, its main aim was to accommodate for a need that has appeared in the Netherlands after the financial crisis (Heijmans, 2014). The movability-aspect of the concept does however make it a durable home. The fact that the house can be redeployed at another site relatively easily ensures that this real estate concept is able to follow market demand more precisely, thereby enhancing economic value. This relates to the disassembly aspect of the circular economy as it was introduced in section 6.1, the main reason behind that requirement is that building components can be used multiple times in several different projects.

**How does this project relate to the circular service level framework and the circular business model prototypes?**
Currently the Heijmans One cannot be compared directly to the circular service level or the business model prototypes. This because the project has not been realized from a circular point of view, and it also does not adhere to the definition of a circular building as maintained in this research.

![Figure L2: The position of Heijmans One in the circular service level framework if the project would adhere to the circular requirements posed in this research (own image).](image)

The concept does make it possible to redeploy the house at several sites during its lifetime. However, no conscious, sustainable material choices have been made, therefore the concept cannot be seen as circular. Furthermore, the different components of the building are not ensured to be implemented in another loop at the end of the house’s lifetime. If these issues are addressed the concept shows potential for advanced level services, especially since the developing party sees the potential of an investor leasing these homes over a prolonged period of time (Appendix T6) (see figure L2).

**Concluding remarks**
The Heijmans One is not circular because no thought has been given to an end-of-life situation, and material-use. The concept does show affinity with some of the proposed requirements for the proper functioning of a circular construction industry as they were outlined in section 6.1. In particular the thought behind the disassembly potential of buildings has been incorporated in the Heijmans One.
Appendix M: Case study: Alliander Headquarters

Figure M1: The renovated Alliander headquarters (Source: RAU, 2016)

Aim of the case study
Alliander claims to have renovated its headquarters in a circular way. This case study’s main goal is therefore inquiring in what manner this has been arranged, also the matter of circularity of the project will be offset against the circular service level framework and circular business model prototypes as provided by this report.

Contents of this case study
Project description, How is circularity realized in this project?, Relation between the project and the circular service level framework and circular business model prototypes.

Project characteristics
Name: Alliander headquarters
Address: Dijkgraaf 4
Duiven
Size (m2): 21.000m2
Delivery: 2015
Supplying parties: VolkerWessels, Innax, RAU architecten, Boele & van Eesteren, Kuiper compagnons, Van Rossum, Turntoo

General project description
Alliander needed a new headquarters since the old headquarters did not longer meet the quality demands of the client. After some consideration it was chosen to renovate the existing site, whilst also adding new building mass on-site. Furthermore it was chosen to renovate the site following circular principles. This was one of the ambitions stated in the ‘programme of ambitions’ that was used in this project instead of the normally used programme of requirements (Loppies, 2015).

How is circularity realized in this project?
As this project deals with a renovation, the first step was making an inventory of those products that were already available in the buildings (appendix T5). These products were then, after identification, refurbished and/or re-used in the renovation. This research states that re-use is not to be considered another loop as no other activities are required to ensure adequate functioning of that product in another project-phase. This does however not mean
that this is a step that should be left out when dealing with a renovation project, it is however not a circular action as it is merely taking advantage of an already existing situation. To clarify this further, think of a situation where the renovation would not have taken place, the existing products would in that case have functioned in the existing building without replacement.

Secondly circularity in this project has been realized through contracts (in a similar way as with the Tennet Centre of excellence) (Appendix T5). Also, the consortium of supplying parties is tied to the project with a DBMO-contract, and therefore remains responsible for the operation of the building for a certain period of time, however there is no ownership on the supply side (Appendix T5; Loppies, 2015). In order to be able to live up to these contracts, the added (new) building mass on-site has been constructed in a way that enables it to be de-constructed at a certain point without too much effort (Appendix T5).

It is worth mentioning that Alliander was looking towards possible ownership by supplying parties (through for instance lease solutions) and advanced circular service opportunities. During the process however, it became clear that by organizing the project in such a way, Alliander would miss out on a substantial subsidies (Appendix T5).

*How does this project relate to the circular service level framework and the circular business model prototypes?*

This project can be considered as a base- to intermediate circular service level project (see figure M2). It is not entirely clear whether it is a base or an intermediate project due to the fact that it is not known to the author until what extent the consortium is responsible for operational activities.

![Figure M2: The position of Alliander in the circular service level framework (own image).](image)

As this project is not an advanced circular services project, it cannot be directly associated with one of the developed prototypes. It can be noted that in order to be able to offer circular services, the supplying parties combined forces into a consortium. Variants 3 and 5 could also be realized through consortia in a similar way albeit with different operational responsibilities.

*Concluding remarks*

Through marketing a programme of ambitions instead of a programme of requirements, Alliander was able to realize a circular building. With closer inspection it shows that the building qualifies for base-to intermediate circular services. This is because circularity is enforced through contracts, but there is no shift in ownership towards the supplying parties. This was not seen as preferable by Alliander as they would miss out on significant subsidies. It is therefore not possible to compare this case directly to the developed prototypes, what
can be said is that both variants 3 and 5 could also be realized through consortia in a similar way (albeit with different operational responsibilities).
In recent years the circular economy has gained significant popularity, however practical implementation of the concept has not followed accordingly. Especially in the construction industry there is a need for a practical translation of the concept. This research makes this translation through the mutual development of circular economy theory and business model prototypes for a circular construction industry. These prototypes are aimed at service providers in the construction industry as it follows from a literature study that these are essential in developing the circular economy in the construction industry. With the development of both the prototypes and theory two important questions surrounding the circular economy are answered in this research. First, how should a service provider organize itself according to the circular economy, and second, how does the service provider relate to current stakeholders in the construction process?