

MASTER

Business ecosystems and the transition to the circular economy

an explorative research into the process of circular business model innovation in a business ecosystem

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BUSINESS ECOSYSTEMS AND THE TRANSITION TO THE CIRCULAR ECONOMY

AN EXPLORATIVE RESEARCH INTO THE PROCESS OF CIRCULAR BUSINESS MODEL
INNOVATION IN A BUSINESS ECOSYSTEM

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12-07-2018

Construction Management and Engineering
Eindhoven University of Technology
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Colophon



Title

Business ecosystems and the transition to the circular economy
An explorative research into the process of circular business model innovation in a business ecosystem

Master Thesis

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"We can't solve problems by using the same kind of thinking we used when we created them." (Albert Einstein)



Preface

The increasing amount of waste, the pollution of our environment, the use of raw materials, and so on. These are all problems that we are facing at the moment and, if we do nothing about this, this will have serious consequences for next generations living on this planet. In order to find a solution to the problem of waste and raw materials in particular, this research focused on the transition to the circular economy at the analysis level of the entire system.

This thesis is the completion of the Master Construction Management & Engineering at the TU Eindhoven. The investigation was carried out over a period of approximately six months. Working on this research has broadened my view and provided me with a lot of new insights. It was a meaningful journey, both in terms of conducting academic research and gaining personal and practical experience with the different concepts. Of course, it was not always easy and this research could not have been carried out without the contribution of many professional people.

First of all I would like to thank my first supervisor, Aant van der Zee of the TU Eindhoven, for his guidance, feedback and encouragement during my graduation period. I have been given a lot of freedom to develop my ideas and to follow my own path. This was also combined with regular and constructive feedback that helped me stay on track during this period. Also, I would like to thank my second supervisor, Qi Han of the TU Eindhoven, for her guidance and feedback during the meetings. I would also like to thank my company supervisor Carolien van Hout-van Delft of Brink Management/Advies. Despite Caroliens' busy schedule, she always made time for me when I needed guidance. Her enthusiasm, critical eye and involvement in the process of my research have brought me a lot. Not only with regard to research, but also in my further practical behaviour in the business world. In addition, I would like to thank the respondents of the examined case, who have been willing to make time available for my research. I would like to take this opportunity to thank Niina Pussinen of ABN AMRO for the time and effort she took to introduce me to these respondents.

Finally, I would like to thank my family and friends for their support, love and moments of distraction. Last but not least, I would like to thank my parents and brothers for their unconditional support, love and trust.

Housni Chaibi
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Summary

The construction sector has a major impact on our environment and is a resource-intensive sector that is responsible for high raw material consumption. 40% of all the waste we produce comes from housing and infrastructure construction and is responsible for about 36% of CO₂ emissions (Schoolderman, 2014). In addition, the sector is estimated to account for 50% of raw material consumption, 40% of total energy consumption and 35% of total water consumption in the Netherlands (Korbee, 2017). The current linear approach of extracting raw materials, processing them into products and destroying them at the end of their life cycle is causing a many damage to the environment. In addition, valuable raw materials are being purchased because we are using too much of them in the current economy (Braas, 2016). A solution can be found in the transition to a circular economy (CE). There are many views on what CE exactly means, but CE can best be defined as: "An industrial system that is restorative and regenerating through design and that aims to keep products, components and materials at their highest utility and value at all times. The concept distinguishes between technical and biological cycles" (Ellen MacArthur Foundation, 2013a).

Unfortunately, it can be said that the construction sector, as a strategic sector for the global economy, is inextricably linked to the (over)exploitation of natural resources. What is remarkable is the large mismatch between waste collection and the eco-benefits resulting from construction activities. Remoy (2013) states, for example, that the Dutch construction sector accounts for 35% of national waste generation, while it represents only 5.1% of gross national product. For an industry with such statistics, it is quite clear that a breakthrough change in business philosophy is urgently needed, because current production practices are far from sustainable and do not guarantee the sustainability of the earth. The transition to the circular economy therefore represents a radical change of direction from the conventional linear economy, which requires other forms of entrepreneurship and organisation. This requires a generation of new business models based on cooperation and value creation between parties in chains and networks. Although, there are business model definitions in which issues such as currency network and system perspective are discussed (Adner, 2009), which means that the business model must also be externally oriented, there is no research into circular business models (CBM) at the analysis level of the total system of the value chain, circular business models in the business ecosystem. A business ecosystem is a network of companies that together develop opportunities for new innovations. These companies work together on new products and services. The aim of this research is to gain insight into how the process of conceiving, developing and implementing a circular business model innovation (CBMI) at the analysis level of a business ecosystem works and to investigate which factors contribute to the success of CBMI in a business ecosystem.

The circular economy (CE) offers a response to the major challenge of the 21st century to use raw materials much more efficiently, but what does this CE actually mean? According to the Ellen MacArthur Foundation (2014) - one of the leading global organizations that invests in the development and promotion of CE principles worldwide - it is a system that is restorative and regenerative through design, aimed at minimizing the access of new materials in the production process, as well as minimizing the associated waste created. The conviction that linear consumption will reach its limits is based on the fact that the amount of resources available for use will decrease in the coming years (Ellen MacArthur Foundation, 2014). This linear consumption is a take-make-waste economy, in which uninhibited use is made of raw materials from which products are made that are thrown away after use. In a circular economy, the reuse of products and raw materials is central.



The major challenge in the construction sector is to use raw materials in a high-quality way, because the recycling that is currently practised largely destroys the added value of building materials and reduces it to the value of the raw material. It is better to reuse building materials or even to realise buildings or parts in a high-quality manner. Circular economy is also about optimal value retention. The shorter the cycle, by reusing the product with as few modifications as possible, the better" (ING, 2017).

The transition to the circular economy is taking place in two areas, namely design, technology and logistics, and the other concerns the business models for the circular economy. The transition needs to be supported and the necessary technological changes need to be stimulated and managed. These systemic changes will only occur if they are supported by business models and made possible by consumer behaviour, legislation, money and money flows and education. If these stimulators have the same goal and work together, they can strengthen each other and help the transition. This research focuses more on the second area, the business models for circular economy. The process of circular business model innovation (CBMI) in a business ecosystem has been investigated.

The transition from the linear to the circular economy will have an impact on the business model, because business simply cannot meet the requirements of circular concepts. This is why new circular business models (CBMs) are needed that close cycles, create collective value and share these values. Construction-related companies can change their role in the sector by looking at these new circular business models or by renewing the current business model to facilitate the transition to the circular economy. We call this circular business model innovation (CBMI). CBMI can take place at two levels, namely at company level and at the level of a business ecosystem. This study focuses on CBMI at the level of a business ecosystem. CBMI in a business ecosystem can be divided into three phases, namely idea, development and implementation. In all three phases, several factors influence the success of a CBMI. The success factors or CBMI in an ecosystem differ from CBMI at company level by a different perspective and level. CBMI in a business ecosystem is not aimed at a company, but at the entire system. This causes a different dynamic and other factors that are important for CBMI. The factors are the requirement of (1) a lead company, (2) trust and control, (3) strategic thinking, (4) absorption capacity and (5) interdependence, in an ecosystem, of the business model.

The empirical research was used to investigate the process of CBMI in a business ecosystem. A single case study was conducted in which extensive interviews were conducted with key parties within the business ecosystem in order to map out the CBMI process. It was investigated which of the above success factors influence the process and in which phase they influence the process. For this case, a CBMI was chosen for the development of a circular building. For the purpose of this research, a circular building is defined as follows: 'A building that has been (re)developed and built on the basis of the principles of the circular economy'. The chosen case is the ABN AMRO pavilion called Circl. This case was chosen because several parties have jointly designed a concept of a circular building in a partnership, despite the fact that the construction sector still builds according to the traditional linear approach.

Literature has shown that the process of innovation in an ecosystem takes place in three main phases: idea, development and implementation. Empirical research shows that these three phases can also be distinguished for circular business model innovation in a business ecosystem. The first phase (idea) is characterised by various attempts and setbacks to give shape to the idea. The second stage concerns development. In this phase, having a good idea is important. It is a major challenge to develop the



idea into a circular business model in order to eventually realise a circular building which requires the commitment of the parties in the ecosystem. During the implementation phase, the business ecosystem will build the circular pavilion. In this case, the configuration of the business ecosystem evolves during the three phases: idea, development and implementation. In each phase, parties are added that can contribute to the realization of the circular business model. After realization, it turned out that the business ecosystem collapsed because various success factors for an innovation in a business ecosystem were no longer present.

To conclude, it can be said that specific insights have arisen about how an ecosystem develops in the process and which factors influence the success of a CBMI in a business ecosystem.



Samenvatting

De bouwsector heeft een grote impact op ons milieu en is een grondstof intensieve sector die verantwoordelijk is voor veel grondstofverbruik. 40% van al het afval dat we produceren is afkomstig van de bouw van woningen en infrastructuur en is verantwoordelijk voor ongeveer 36% van de CO₂-uitstoot (Schoolderman, 2014). Daarnaast is de sector naar schatting goed voor 50% van het grondstofverbruik, 40% van het totale energieverbruik en 35% van het totale waterverbruik in Nederland (Korbee, 2017). De huidige lineaire aanpak waarbij grondstoffen worden gewonnen, verwerkt tot een product en vernietigd aan het eind van hun levensduur, brengt veel schade toe aan het milieu. Daarnaast nemen waardevolle grondstoffen af, omdat we er in de huidige economie te veel van gebruiken (Braas, 2016). Een oplossing kan gevonden worden in de transitie naar een circulaire economie (CE). Er zijn veel opvattingen over wat CE exact betekent, maar CE kan het beste worden gedefinieerd als: *"Een industrieel systeem dat herstellend en regenererend is door ontwerp en welke ernaar streeft om producten, componenten en materialen te allen tijde op hun hoogste nut en waarde te houden. Het concept maakt hierin een onderscheid tussen technische en biologische cyclus"* (Ellen MacArthur Foundation, 2013a).

Helaas kan er gesteld worden dat de bouwsector als strategische sector voor de wereldeconomie onlosmakelijk verbonden is met de (over)exploitatie van natuurlijke grondstoffen. Opvallend is de grote wanverhouding die bestaat tussen afvalinzameling en het eco-voordeel dat uit bouwactiviteiten voortkomt. Zo geeft Remoy (2013) aan dat de Nederlandse bouwsector 35% van de nationale afvalproductie voor zijn rekening neemt, terwijl deze slechts 5,1% van het bruto binnenlands product vertegenwoordigt. Voor een industrie met dergelijke statistieken is het overduidelijk dat een baanbrekende verandering in de bedrijfsfilosofie dringend nodig is, omdat de huidige productiepraktijken verre van duurzaam zijn en de duurzaamheid van de aarde niet garanderen. De overgang naar de circulaire economie betekent dan ook een radicale koerswijziging ten opzichte van de conventionele lineaire economie die andere vormen van ondernemerschap en organisatie vereist. Dit vraagt om een generatie van nieuwe businessmodellen die gebaseerd zijn op samenwerking en waarde creatie tussen partijen in ketens en netwerken. Hoewel er business model definities zijn waarin zaken worden besproken als valutanetwerk en systeemperspectief (Adner, 2009), wat betekent dat het business model ook extern georiënteerd moet zijn, is er geen onderzoek naar circulaire business modellen (CBM) op het analyiseniveau van het totale systeem van de waardeketen, circulaire business modellen in het business ecosysteem. Een business ecosysteem is een netwerk van bedrijven die samen kansen ontwikkelen voor nieuwe innovaties. Deze bedrijven werken samen aan nieuwe producten en diensten. Het doel van dit onderzoek is om inzicht te krijgen in hoe het proces verloopt van idee, ontwikkeling en implementatie van een circulair businessmodel innovatie (CBMI) op het analyiseniveau van een business ecosysteem en om te onderzoeken welke factoren bijdragen aan het succes van CBMI in een business ecosysteem.

De circulaire economie (CE) biedt een antwoord op de grote uitdaging van de 21ste eeuw om veel efficiënter om te gaan met grondstoffen, maar wat betekent dit CE nu eigenlijk? Volgens de Ellen MacArthur stichting (2014) - een van de toonaangevende wereldwijde organisaties die investeert in de ontwikkeling en promotie van CE-principes wereldwijd - is het een systeem dat herstellend en regeneratief is door ontwerp, gericht op het minimaliseren van de toegang van nieuwe materialen in het productieproces, evenals het minimaliseren van de bijbehorende gecreëerde afval. De overtuiging dat het lineair verbruik zijn grenzen zal bereiken, komt voort uit het feit dat de hoeveelheid middelen die beschikbaar zijn voor gebruik de komende jaren zal afnemen (Ellen MacArthur Foundation, 2014). Dit lineaire verbruik is een take-make-waste economie, waarbij ongeremd gebruik wordt gemaakt van



grondstoffen waaruit producten worden gemaakt die na gebruik worden weggegooid. In een circulaire economie staat hergebruik van producten en grondstoffen centraal.

De grote uitdaging in de bouwsector is om grondstoffen op een kwalitatief hoogstaande manier te gebruiken, omdat de nu gangbare recycling de toegevoegde waarde van bouwmaterialen grotendeels tenietdoet en reduceert tot de waarde van de grondstof. Het is beter om bouwmaterialen te hergebruiken of zelfs gebouwen of onderdelen op een kwalitatief hoogstaande manier te realiseren. Circulaire economie gaat dan ook over optimaal waarde behoud. Hoe korter de cyclus, door het product met zo min mogelijk aanpassingen te hergebruiken, hoe beter" (ING, 2017).

De transitie naar de circulaire economie vindt plaats op twee gebieden, namelijk op het gebied van ontwerp, technologie en logistiek, en de andere heeft betrekking op de businessmodellen voor de circulaire economie. De overgang moet worden ondersteund en de vereiste technologische veranderingen moeten worden gestimuleerd en gestuurd. Deze systemische veranderingen zullen zich alleen kunnen voordoen als ze worden ondersteund door businessmodellen en waarbij ze mogelijk worden gemaakt door consumentengedrag, wetgeving, geldstromen en educatie. Als deze stimulators hetzelfde doel hebben en samenwerken, kunnen ze elkaar versterken en de transitie versnellen. Dit onderzoek richt zich meer op het tweede gebied, de businessmodellen voor circulaire economie. Het proces van circulaire businessmodel innovatie (CBMI) in een business ecosysteem is onderzocht.

De overgang van de lineaire naar de circulaire economie zal een impact hebben op het businessmodel, omdat business simpelweg niet kan voldoen aan de eisen van circulaire concepten. Daarom zijn er nieuwe circulaire businessmodellen (CBMen) nodig die kringlopen sluiten, collectieve waarde creëren en deze waarden delen. Aan de bouwsector gerelateerde bedrijven kunnen hun rol in de sector veranderen door te kijken naar deze nieuwe circulaire businessmodellen of door het huidige businessmodel te vernieuwen om de overgang naar de circulaire economie te vergemakkelijken. We noemen dit circulaire businessmodel innovatie (CBMI). CBMI kan op twee niveaus plaatsvinden, namelijk op bedrijfsniveau en op het niveau van een business ecosysteem. In deze studie ligt de focus op CBMI op het niveau van een business ecosysteem. CBMI in een business ecosysteem kan worden onderverdeeld in drie fasen, namelijk idee, ontwikkeling en implementatie. In alle drie de fasen zijn verschillende factoren van invloed op het succes van een CBMI. De succesfactoren of CBMI in een ecosysteem verschillen van CBMI op bedrijfsniveau door een ander perspectief en niveau. CBMI in een business ecosysteem is niet gericht op een bedrijf, maar op het hele systeem. Dit veroorzaakt een andere dynamiek en andere factoren die belangrijk zijn voor CBMI. De factoren zijn de vereiste van (1) een lead bedrijf, (2) vertrouwen en controle, (3) strategisch denken, (4) absorptiecapaciteit en (5) onderlinge afhankelijkheid, in een ecosysteem, van het businessmodel.

Het empirisch onderzoek is gebruikt om het proces van CBMI in een business ecosysteem te onderzoeken. Er is een single casestudie gedaan waarbij uitgebreide interviews zijn gedaan met belangrijke partijen binnen het business ecosysteem om het proces van CBMI in kaart te brengen. Daarbij is onderzocht welke van de bovenstaande succesfactoren van invloed zijn op het proces en in welke fase ze het proces beïnvloeden. Voor deze case werd gekozen voor een CBMI voor de ontwikkeling van een circulair gebouw. Voor dit onderzoek wordt een circulair gebouw als volgt gedefinieerd: *'Een gebouw dat is (her)ontwikkeld en gebouwd op basis van de principes van de circulaire economie'*. De gekozen case is het paviljoen van de ABN AMRO genaamd Circl. Deze case is gekozen omdat verschillende partijen samen een concept van een circulair gebouw hebben



ontworpen in een samenwerkingsverband, dit ondanks het feit dat de bouwsector nog steeds volgens de traditionele lineaire benadering bouwt.

Uit de literatuur is gebleken dat het proces van innovatie in een ecosysteem in drie hoofdfasen plaatsvindt: idee, ontwikkeling en implementatie. Het empirisch onderzoek laat zien dat deze drie fasen ook te onderscheiden zijn voor circulaire businessmodel innovatie in een business ecosysteem. De eerste fase (idee) kenmerkt zich door verschillende pogingen en tegenslagen om het idee vorm te geven. De tweede fase betreft de ontwikkeling. In deze fase is het hebben van een goed idee belangrijk. Het is een grote uitdaging om het idee te ontwikkelen tot een circulair businessmodel om uiteindelijk een circulair gebouw te realiseren welke de inzet van de partijen in het ecosysteem vereist. Tijdens de implementatiefase realiseert het business ecosysteem het circulair paviljoen. In deze casus evolueert de configuratie van het bedrijfsecosysteem tijdens de drie fasen: idee, ontwikkeling en implementatie. In elke fase worden partijen toegevoegd die kunnen bijdragen aan de realisatie van het circulair businessmodel. Na realisatie is gebleken dat het business ecosysteem uit elkaar is gevallen doordat verschillende succesfactoren voor een innovatie in een business ecosysteem niet meer aanwezig waren.

Ter afsluiting, kan er gesteld worden dat er specifieke inzichten zijn ontstaan over hoe een ecosysteem zich ontwikkelt in het proces en welke factoren van invloed zijn op het succes van een CBMI in een business ecosysteem.



Abstract

The construction sector has a major impact on our environment and is a resource-intensive sector that is responsible for high raw material consumption. Today's linear economy is based on the take-make-dispose model in which raw materials are extracted, processed into a product and destroyed at the end of their life time. This model causes a great deal of damage to the environment, creating huge quantities of waste. A solution to minimize these waste streams can be found in the transition to a circular economy. This transition means a radical change of direction compared to the conventional linear economy that requires other forms of entrepreneurship and organisation. This calls for a generation of new business models based on cooperation and value creation between parties in chains and networks. Although there are business model definitions in which issues such as currency network and system perspective are discussed, which means that the business model also needs to be externally oriented, but there is no research on circular business models (CBM) at the analysis level of the total system of the value chain, CBM in the business ecosystem. The aim of this research was to gain insight into the process of idea, development and implementation of a circular business model innovation (CBMI) at the analysis level of a business ecosystem and to investigate which factors contribute to the success of CBMI in a business ecosystem. The literature review provides insight into the success factors that influence a CBMI in a business ecosystem and the phases that the CBMI process goes through. The empirical research was used to investigate the process of CBMI in a business ecosystem. A single case study was conducted in which extensive interviews were conducted with key parties within the business ecosystem in order to map out the CBMI process. It was investigated which of the above success factors influence the process and in which phase they influence the process. It can be said that specific insights have arisen about how an ecosystem develops in the process and which factors influence the success of a CBMI in a business ecosystem.



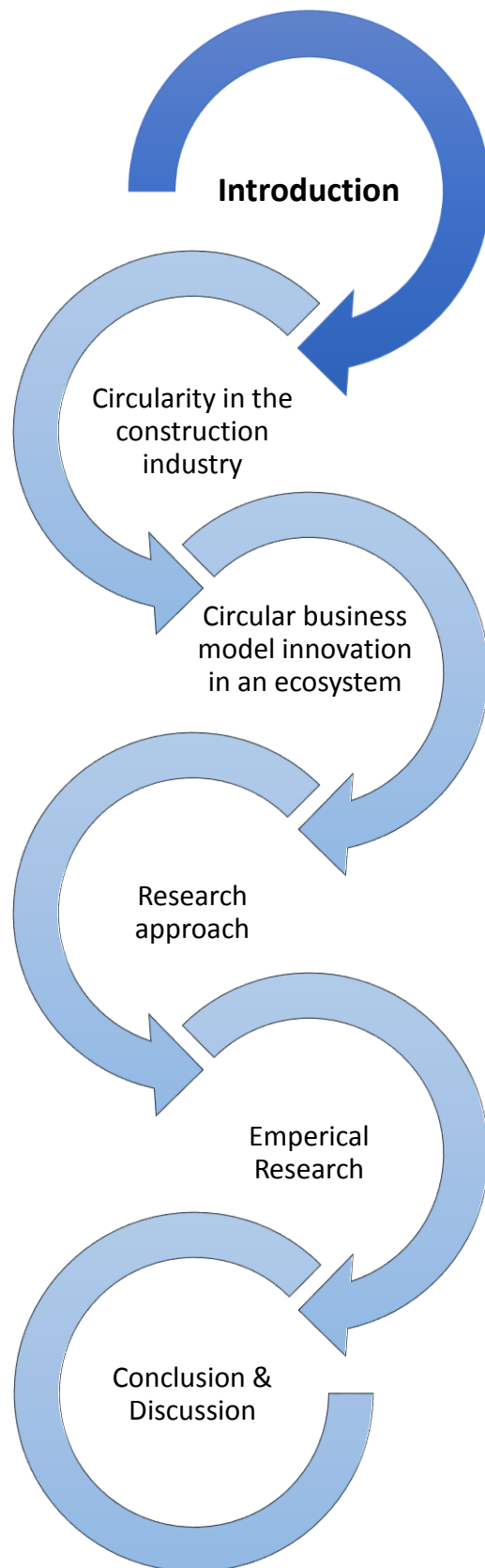
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1. Introduction

1.1. Problem definition

The construction sector has a major impact on our environment and is a raw material intensive sector that is responsible for a lot of raw material consumption. 40% of all the waste we generate derives from housing and infrastructure construction, and accounts for about 36% of CO₂ emissions (Schoolderman, 2014). In addition, the sector is estimated to account for 50% of the raw material consumption, 40% of total energy consumption and 35% of total water consumption in the Netherlands (Korbee, 2017). The current linear approach whereby raw materials are extracted, processed into a product and destroyed at the end of its life time, brings a lot of damage to the environment, says researcher Wouter Thierie (Thierie, 2017). In addition, valuable raw materials are decreasing ever since we use too many of them in the current economy (Braas, 2016). Therefore, the circular approach to recycling is becoming increasingly unavoidable. The concept of circular economy (CE) describes an economy with closed loops. Closing material loops can be a solution to economic, environmental (and social) problems caused by the (rate of) extraction of raw materials.

Unfortunately, it can be said that the construction sector is inextricably linked to the (over) exploitation of natural resources as a strategic sector for the global economy. What is very remarkable, is the big disproportion that exists between waste collection and the eco-advantage that gets out of construction activities. To give an example, Remoy (2013) states that the Dutch construction sector accounts for 35% of national waste production, when it represents only 5.1% of the gross domestic product (R. Geraedts & J. Ruiterkamp, 2015). Apparently, for an industry with such statistics, it is more than obvious that a pioneering change in the business philosophy is urgently needed, because the current production practices are far from serving sustainability and guarantee the longevity of the earth.

At the end of 2015, the European Commission approved an ambitious action plan 'Circulate the circle' (Commission, 2015), to promote the transition to a circular economy and more sustainable growth. This European long-term plan will affect every market, including construction sector. In line with this, our Dutch government has drawn up the program 'the Netherlands Circular in 2050', with strategic objectives to use as many renewable raw materials as possible in the construction industry and to reduce CO₂ emissions. Also, the coalition agreement of Rutte III, reference was made to this Government-wide Circular Economy program which is presented in 2016 (Janssen, 2017). The aim of this program is a fully circular economy in 2050 with a 50% reduction in the consumption of primary raw materials (mineral, fossil, and metals) in 2030 (Rijksoverheid, 2016). The transition from linear to circular involves a shift from 'win-make-use-throw' to a system that uses as few as possible new raw materials.

The concept of circular economy (CE) is inspired by nature, where the term 'waste' is absent, landfills do not exist and all elements flow constantly in circles, because after the end of their life-time they constitute the main ingredients for another life (ING, 2015). The circular model takes into account the impact of the extraction of natural raw materials and avoids wastage. It offers opportunities for alternative value creation, where used raw materials are reused for production and ultimately for consumption again. Therefore, the aim of the circular economy is to reduce pollution and waste as far as possible. In the most favourable case, the raw materials never get lost because the chain is completely closed (see figure 1).

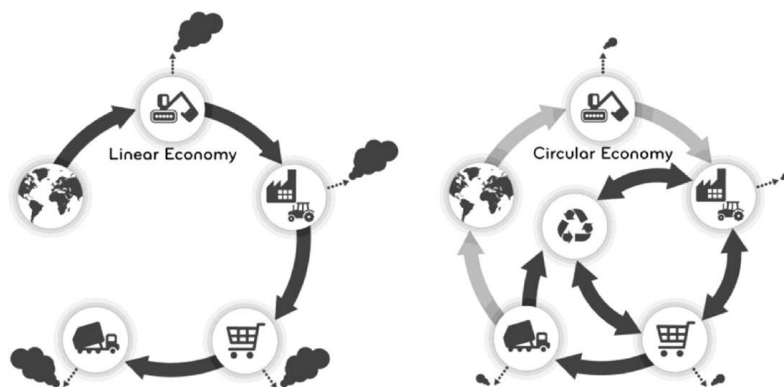


Figure 1 - Linear and circular economy (S. Sauvé, S. Bernard & P. Sloan, 2016)

This different way of working also requires a different way of doing business. Therefore, for the transition to the circular economy, issues arise from the fact that a new economy arises that differs fundamentally from the current linear economy, which also originates from it. In other words, the transition to the circular economy means of course a radical change in relation to the conventional linear economy that requires other forms of entrepreneurship and organization. This necessitates a generation of new business models that are based on cooperation and value creation between parties in chains and networks. The research by Jan Jonker (2016) shows that various formats can be found in the literature of circular business models. A general business model can be characterized as the way values are created where circular business models distinguish themselves from other models by creating value by using the non-circular gaps in the current system. This makes linear 'leakage' the raw material for circular business models (Jonker, 2016).

A first exploration in the literature shows that studies about business models and circular business models (business models for the circular economy) often have a conceptual perspective and are approached from the analysis level of companies with the focus on their own business operations. The consequence of this focus is that chain collaboration or joint (multi-party) business models still do not occur enough. Although, there are business model definitions that discuss issues such as value network and system perspective (Adner, 2009) which means that the business model construct also has to be externally oriented, there is no research into circular business models on the analysis level of the total system of the value chain, forms of cooperation or circular business models in the business ecosystem. Business ecosystems have the biological ecosystem as a metaphor for interdependence. One of the most important starting points is that all elements of the ecosystem are dependent on each other and that if something changes in the Ecosystem, this also has an impact on other participants in the ecosystem (Loon, 2013).

In short, in an ecosystem, the participants are one entity and are interdependent. Research into business ecosystems indicates the importance of business ecosystems in relation to innovation and strategy. Innovation can only be achieved through innovation in the ecosystem and although research has been done on innovation in a business ecosystem, there is a gap in the literature where studies connect both concepts and provide insight into the process of business models innovation for circular economy at the level of analysis of the business ecosystem. Therefore, this research aims to provide scientific insights for the realization of this transition process at the analysis level of the business ecosystem (at the level of the total system).



1.2 Research objective

The aim of the research is exploratory in nature. The main goal of exploratory research is to clarify the research problem (Verschuren, 2015). Identifying the main challenge of the applicability of CE at the level of the total system, and recognizing the current impossibility of the construction industry to strategically focus on a transition to the circular economy, will be important components for this research. Based on the existing theory of the concepts of business models for circular economy and ecosystems, the research objective is as follow: *this research aims to contribute to the literature by providing insight into how business models for circular economy work on business ecosystem level, instead of at company level and by providing insight into how the process of circular business model innovation in an Ecosystem comes into being and which success and failure factors affect this.*

1.3 Research questions

On the basis of the problem analysis and the objective, a leading question for this research is drawn up. This leads to the following main question:

Main question

How does the process of a circular business model innovation (CBMI) take place in a business ecosystem for the construction sector?

In order to answer the main question, the following sub-questions will be answered first:

Sub-questions

1. *What is the circular economy?*
2. *What does the circular economy encompass for the construction sector?*
3. *How is a circular business model for the construction sector set up?*
4. *What is circular business model innovation?*
5. *What are business ecosystems?*
6. *Which success and failure factors plays a role for a circular business model innovation in a business ecosystem?*

1.4 Scientific relevance

This research is of high scientific relevance because of the limited scientific publications on circular business model innovation, especially with regard to the analysis level of the entire system, business ecosystems. This research contributes to the insight into how the process from idea till implementation proceeds at the level of a business ecosystem. It also provided insight into which factors could influence the successful course of business model innovation in a business ecosystem. It will also provide insight into how the factors influence the success of innovation in the business ecosystem during the course of the process. By means of a case study, an attempt was made to validate the findings from the literature in practice in order to create new insights for further research.



1.5 Societal relevance

The construction sector is a raw material intensive sector that is responsible for 50% of raw materials consumption. In addition, the growing world population, which is becoming increasingly more prosperous, requires more and more food and products. Ultimately, the earth can no longer meet this demand. Therefore, the transition from the linear to the circular economy becomes increasingly necessary. Because this transition to the circular economy is still in its early stages, this research gives managers of companies that are related to the construction sector more insight into how a process progresses and how partnerships are formed to build according to the principles of the circular economy.

1.6 Research method

A qualitative research strategy was chosen based on a case study. This is a form of empirical research in which it is not a matter of mapping static data, but of exploring and providing insight into a theme or issue (N. Reulink & L. Lindemand, 2005). This qualitative method was chosen because this is the best way to gain an overarching perspective on the process of applying a circular business model in a Business Ecosystem. Theory developed on the basis of case study research has important strengths such as testability and empirical validity, which arise through the link with empirical evidence. Qualitative research is suitable for new research areas for which the existing theory seems inadequate. This kind of research is complementary to qualitative increasing theory formation of other scientific research (Eisenhardt, 1989).

External reliability is the extent to which a study can be replicated (H. Everaert & A. van Peet, 2006). In qualitative research this can be difficult to meet, but this type of research has the opportunity to gain insight into an incomplete literature of circular business models in an ecosystem. A conscious choice has been made for this type of research by weighing the lack of external reliability against the possibility of gaining insight.

Within this research, six phases will be completed on the basis of the Yin step-by-step (2009) plan:

- Determine and define the research
- Select the cases and determine data gathering and analysis techniques
- Prepare to collect data
- Collect data in the field
- Evaluate and analyse the data
- Prepare the report

Firstly, a plan has been developed / drawn up, then a plan will be designed and prepared by designing the method of research (methodology), and a literature study will take place. Afterwards, data will be collected through interviews and source documents. Then, these are analysed and finally they are presented through this thesis.

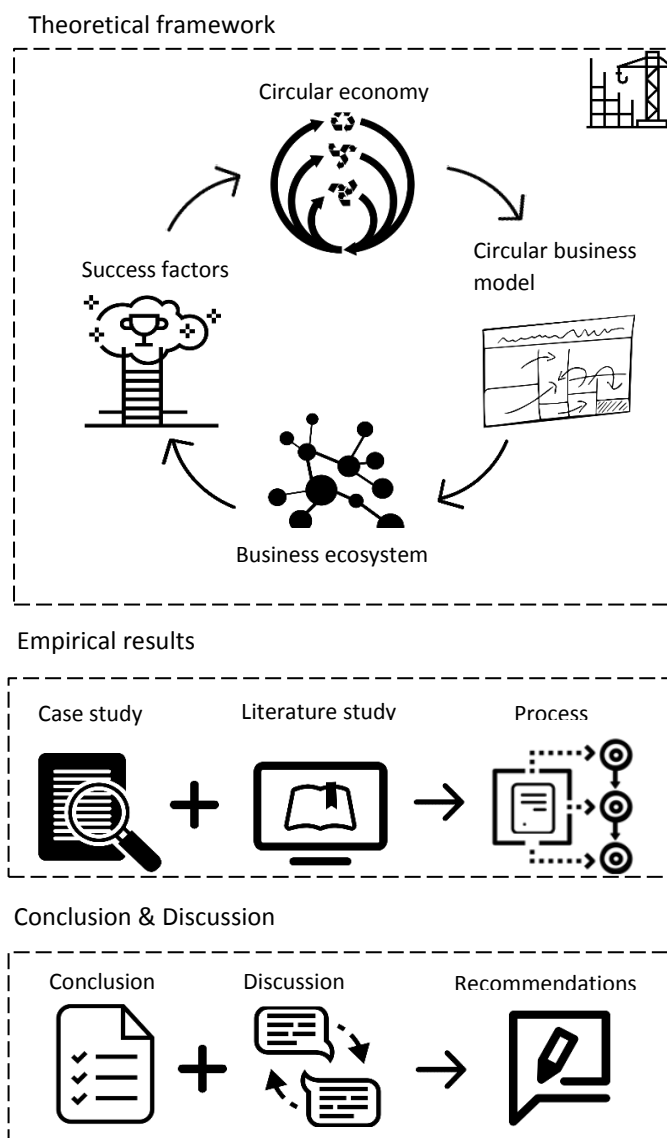
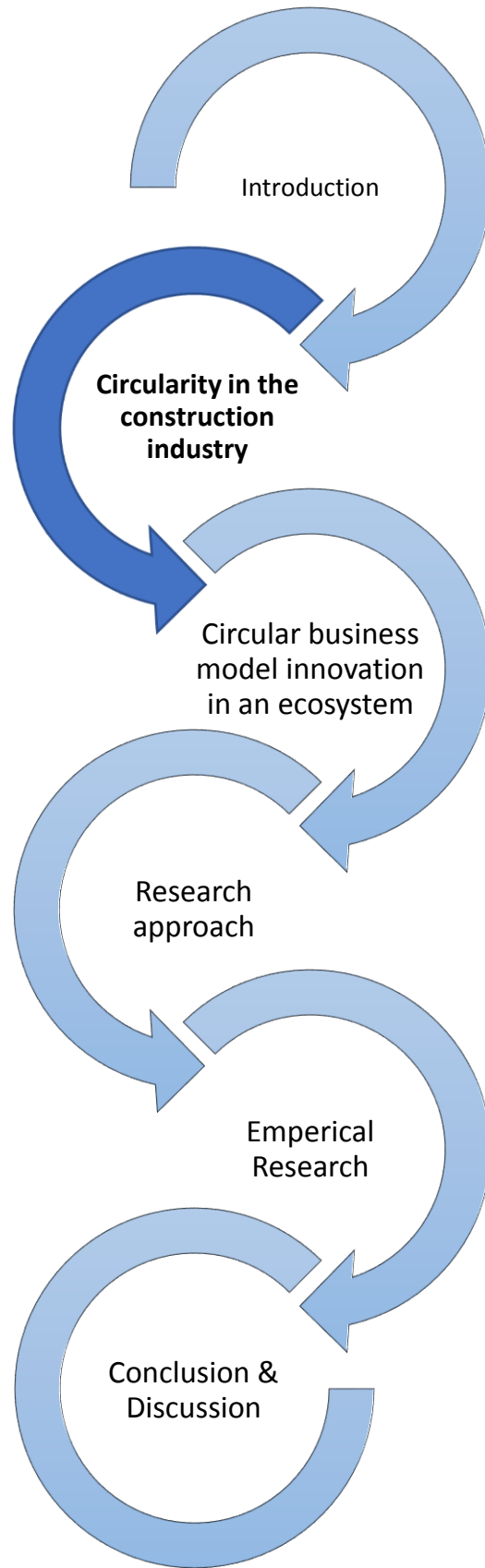


Figure 2 - Research design (own illustration, 2018)

1.7 Reading guide

In chapter 1, the topic has been introduced, including the context of the problem, research questions and the research method. In chapter 2 a description is given of the existing literature on circular economy and illustrates a circular economy in the construction sector. In chapter 3, the literature review of circular business model innovation, and business ecosystems. In chapter 4, the research method is described in detail. The case is described and the participants in the interviews are explained in this chapter. In chapter 5, the results of the empirical research are presented, analysed and compared to existing insights from the literature. In chapter 6 (conclusion), answers to the research questions are presented. In chapter 7 (discussion), outcome of this research are reflected based on the conclusion and recommendations for further research are presented.





2. Circularity in the construction industry

2.1 Introduction

This chapter will give a general introduction of the circular economy concept as it is presented through literature. Also, this chapter will describe what the circular economy means for the construction industry. The way in which the construction industry is currently structured and managed is quite important for the way projects are usually organized. Moreover, this is also important for the material flow and energy used in the current linear economy. In order to gain more insight into the transition that needs to be made to the circular economy, this chapter aims to investigate what the circular economy means for the construction sector.

2.2 The concept of the circular economy

The circular economy offers an answer to the major challenge in the 21st century to deal with raw materials much more efficiently. In the introductory chapter, a brief description of what the circular economy (CE) is, was made. However, as the context of this thesis is inextricably linked to that concept, some more details will be provided. So, what does this CE really mean? According to the Ellen MacArthur foundation (2014) –one of the leading global organizations investing on the development and promotion of CE principles worldwide- it is a system which is restorative and regenerative by design, aiming to minimize the entrance of virgin materials into the production process, as well as to minimize the corresponding created waste.

The circular economy concept stems from the believe that linear consumption will reach its limits in the foreseeable future, and is builds upon the cradle-to-cradle theory (Ellen MacArthur Foundation, 2014). Cradle to Cradle is a design concept by architect William McDonough and chemist Michael Braungart on the basis of eco-effectiveness. Cradle to Cradle means that products should be designed in such a way that they can be reused in a new product in a high-quality way after use, or have a nourishing function. This theory is based on three principles (M. Braungart, W. McDonough & A. Bollinger, 2007): (1) Waste equals food: everything is seen as a nutrient for something else. (2) Use of solar energy: Only renewable energy is used since it can be renewed when used. (3) Celebrate diversity: make use of the different species, cultural and innovation diversity.

The belief that linear consumption will reach its limits originates from the fact that the amount of resources available for use will decrease over the next years (Ellen MacArthur Foundation, 2014). This linear consumption is a take-make-waste economy, where unrestrained use is made of raw materials from which products are made that are thrown away after use. In a circular economy, the reuse of products and raw materials is central. Waste and harmful emissions to soil, water and air are prevented as much as possible ('the closing of cycles').

As mentioned earlier, the Ellen MacArthur foundation is the main promoter of the circular economy (CE) and the concept of CE has increased in popularity over the last years. According to Stigter (2016), the following three major changes have led to this development;

1. Increasingly volatile commodity prices. Raw materials 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 (C. Bakker, F. Wang, J. Huisman & M. den Hollander, 2014)



2. The technical capacity of information systems, technology enables new business models, which were not feasible before;
3. There is a shift in consumer behaviour that leads to a performance over an ownership mentality.

2.2.1 Definition of circular economy

The current economic model of win-make-use-throw is not sufficient anymore. In the long run, there is no perspective for this economic model. That is the reason why the Ellen MacArthur Foundation (EMF) is focusing on the concept of circular economy. 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. But in order to give a certain basis to this research, the EMF perspective on the circular economy will be used as the main reference for a definition since this perspective has been widely adopted by industry, government and academia. Their definition of circular economy is described as follow: *“A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. The concept distinguishes between technical and biological cycles.”* (EMF, 2015)

Michael Braungart and William McDonough set in their Cradle to Cradle philosophy the technological or biological cycles as ways to reuse raw materials without quality loss. In the technical cycle, the raw materials are made by humans and in a biological cycle, the raw materials are biodegradable. Reusing materials is the most well-known of a circular economy. Joni Braas (2016) explains the harmful effects on people and nature. She defines that healthy materials should be used in a circular economy. Next to that, she argues that renewable energy should be chosen, to focus on the environment and its history and that there are social justice and ethics. In addition, in a circular economic system, financial value creation and a value for flora and fauna are provided (Braas, 2016).

2.2.2 Circular economy principles

EMF presents five circular economy principles to operationalize the concept of CE (Ellen MacArthur Foundation, 2013a):

1. **Design out waste:** all components of a product are designed to fit within the biological or technical cycle (figure 3) by disassemble and refurbishment in order to eliminate waste. Components of the biological cycle are compostable and non-toxic. Components of the technical cycle are reusable with high quality and minimal energy usage
2. **Build resilience through diversity:** Balance efficiency with adaptability. To meet this challenge, systems need to be constructed in which diversity, complexity and uniformity are combined to adapt to the environmental conditions.
3. **Shift to renewable energy sources:** To create circularity, circular energy sources need to be used throughout the whole economic lifecycle of the product (taxed energy and materials instead of labour).
4. **Think in systems:** Being able to think in systems is crucial for understanding the influences and relationships within its social context and towards its environment and infrastructure. Thinking in systems is a scientific approach that seeks to maintain an overview of the whole, rather than focusing on individual parts without considering the role they play in the greater whole. Each product/service is part of such a system or forms a system in itself and is influenced over time,



influences other parts or systems and may change throughout its lifespan. In addition, such systems need to be seen as iterative, non-linear processes, whereby a small decision can have an unexpected multiplied result. Therefore, it is necessary to consider the system as a whole and do not focus on individual parts.

5. **Think in cascades (waste is food):** Organic nutrients are reintroduced into the biological cycle to become valuable raw materials. In addition, waste that follows the linear process or other rest-products are reintegrated into the technical cycle to restore the original quality through maintenance, reuse / re-distribution, refurbishment / re-manufacture or recycling or even a higher level of quality by means of the so-called upcycling.

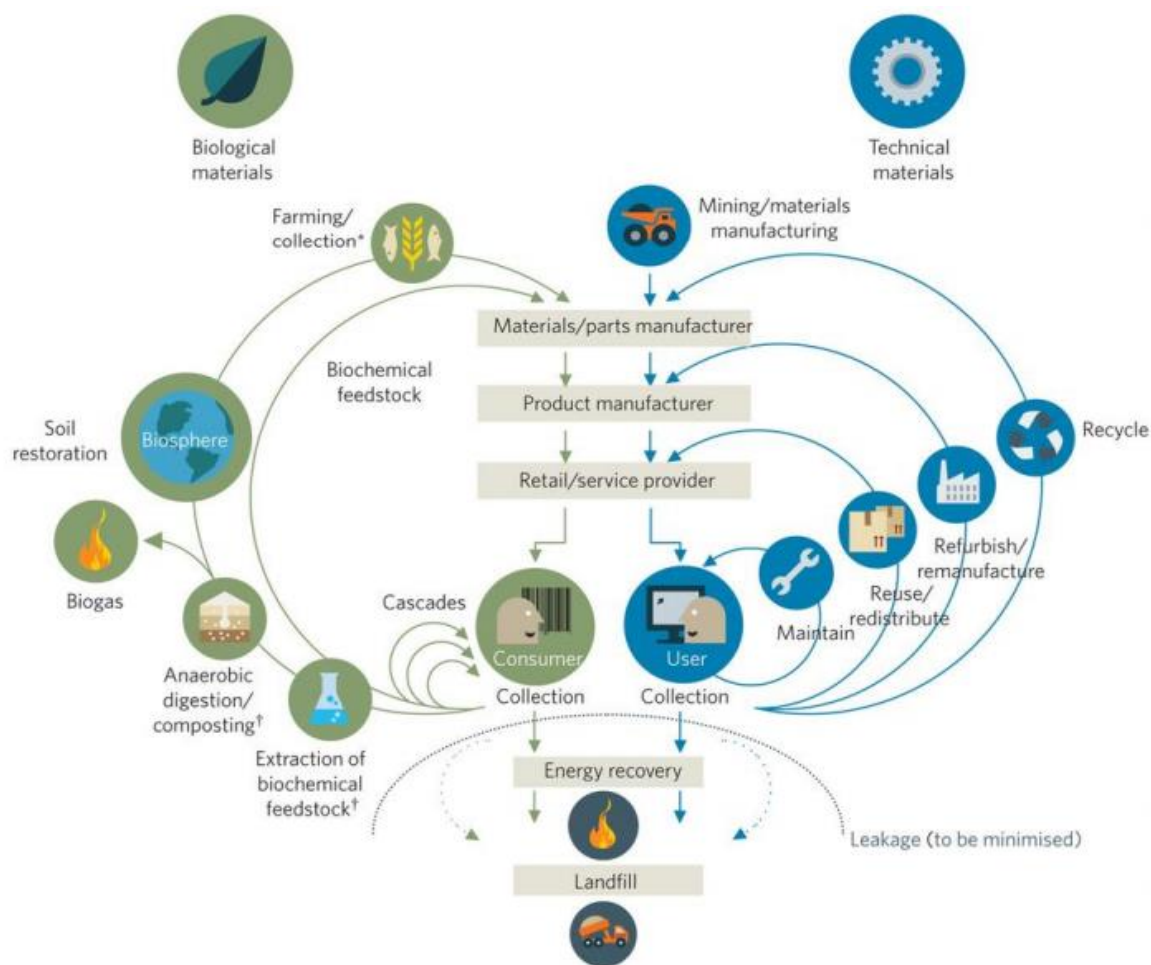


Figure 3 - A schematic overview of the circular economy and its activities (Ellen MacArthur Foundation, 2013)

Figure 3 give a clear insight on the basic structure of the CE. Closing material loops and creating value along the whole system requires specific economic activities like remanufacturing or recycling. Through a series of material circuits- represented by green (biological cycle) and blue (technical cycle) colours- CE aspires to create value by adapting them accordingly once they stop delivering the desired performance instead of qualifying it as waste (Stigter, 2016). Thus, the concept tries to prevent the unnecessary use of raw materials by closing these cycles as much as possible. An important motivation for this, is that it will become cheaper in the future to reuse products rather than making new products, because it is assumed that the prices of raw material will undergo a significant growth (Ellen MacArthur Foundation, 2014). The cycles in Figure 3 give examples of the routes that can be taken when a product life cycle has ended. It is important to mention that the 'short' routes are preferred over the 'long' routes; 'Maintenance' is, for example, considered more favourable than 'refurbish / remanufacture',



because of the extra costs of being lower in shorter cycles compared to longer cycles. At least in principle, because a shorter router implies less energy, costs and effort for restoring functionality or changing the operational scope of the circulated products (Ellen MacArthur Foundation, 2014).

In addition to the principles presented by EMF, Joustra et al. (2013) appends the following principle:

6. **Share values:** Describes the economic concept of doing business, making products and making profit. Within the circular economy, cooperative entrepreneurship and performance are used to create shared value, which help to maintain long term business collaborations (D. J. Joustra, E. de Jong & F. Engelaar, 2013). This not only increases the economic value of all companies, but also the ecological and social value.

EMF have been translated their principles of the circular economy into a set of six business actions: Regenerate, Share, Optimise, Loop, Virtualise, and Exchange – together, the ReSOLVE framework (see table 1) (EMF, 2015). This framework offers a tool for generating circular strategies and growth initiatives. Each of the six actions represents a major circular business opportunity which, enabled by the technology revolution, looks quite different from what it would look like in a framework for growth in the linear economy. In different ways, these actions all increase the utilisation of physical assets, prolong their life, and shift resource use from finite to renewable sources. Each action reinforces and accelerates the performance of the other actions (EMF, 2015).

Table 1- The ReSOLVE framework: six action areas to move towards the circular economy (EMF, 2015)

REGENERATE	<ul style="list-style-type: none"> - Shift to renewable energy and materials - Reclaim, retain, and restore health of ecosystems - Return recovered biological resources to the biosphere
SHARE	<ul style="list-style-type: none"> - Share assets (e.g. cars, rooms) - Reuse - Prolong life through maintenance, design for durability, upgradability, etc.
OPTIMISE	<ul style="list-style-type: none"> - Increase performance/efficiency of product - Remove waste in production and supply chain - Leverage big data, automation, remote sensing and steering
LOOP	<ul style="list-style-type: none"> - Remanufacture products or components - Recycle materials - Digest anaerobically - Extract biochemical from organic waste
VIRTUALISE	<ul style="list-style-type: none"> - Dematerialise directly - Dematerialise indirectly
EXCHANGE	<ul style="list-style-type: none"> - Replace old with advanced non-renewable materials - Apply new technologies - Choose new product/service

2.2.3 Drivers of moving to CE

The previous paragraphs describe the concept, the principles and the possible actions that can be taken by entrepreneurs to generate circular strategies. But what changes drive companies to move towards a circular economy? These changes are (Schoolderman, 2014):



- Fluctuating raw material prices (and the uncertainties about availability)
- Changing consumer preferences;
- Changing manners: more value to cooperation and co-organizing, co-creation;
- A stricter government policy (national and European) regarding the efficient use of resources and circular enterprise.

Considering these changes, there are some benefits for entrepreneurs of moving toward a circular economy (CE). The market for CE is growing. It is estimated that over the next 10 years, this will boost economic growth by up to 4% (ING, 2015). According to FinanCE (2016), the transition from linear to circular economy (CE) takes place in two areas. The first one relates **to the flow of products from materials to the final consumer**, and vice versa, representing the necessary changes in design, technology and logistics which are defined above by means of the principles of CE and the ReSOLVE framework (Table 1). The second one **reflects on the business models for circular economy**, including the way money flows and business' activities are organized. The second area is also the focus of this research. In chapter three, these business models will be discussed more in detail. First insight will be given into what the CE means for the construction and why a transition is important for this sector.

2.3 The construction industry and circular economy

The construction sector is a resource intensive sector which is responsible for a lot of raw material use and waste generation. As described in chapter 1, the construction sector is responsible for 50% of raw material consumption in the Netherlands. In addition, 40% of all waste in the Netherlands relates to construction and demolition waste (cdw) (Schoolderman, 2014). Recycling of cdw is already happening on a large scale in the Netherlands, even though it often involves down cycling. An example of this is the building rubble that is processed into granules for road construction. This is a step in the right direction, but it doesn't stop the demand for raw materials at the front of the chain. The big challenge in the construction sector is to use raw materials in a high-quality way because the now common recycling largely destroys the added value of building materials and reduces them to the value of the raw material. It is better to reuse building materials or even complete buildings or building parts in a high-quality way. In construction, this can be done by transformation or renovation for an entire building. Circular economy is about optimum value retention. "The shorter the cycle, by re-using the product with as few adjustments as possible, the better" (ING, 2017).

In addition to the need to minimize pollution and the future exhaustion of raw materials, the circular economy can also offer other benefits in the construction sector. In the MVO report 'Entrepreneurship in the circular economy' the construction sector is explicitly tested on suitability for implementing circular revenue models. For example, the report emphasizes the impact of the circular economy on non-residential construction on the basis of the 'Total Impact Measurement & Management' method developed by Price Waterhouse Coopers (PwC) for the valuation of social, environmental, fiscal and economic consequences of a project or a business model. Table 2 illustrates the difference between traditional linear construction and construction according to the principles of the circular economy (Schoolderman, 2014).



Table 2 - Total Impact Measurement & Management (Schoolderman, 2014, p. 53)

	LINEAR	CIRCULAR	EXPLANATION
ENVIRONMENTAL IMPACT			
Fossil energy	83 kWh / m2 electricity 20 m3 / m2 natural gas (fossil and from renewable sources)	0 kWh / m2 electricity 0 m3 / m2 of natural gas (except for energy from fully renewable sources)	source: Agentschap NL (2012) Quantitative data research Energy innovations CE starting point is pure sustainable energy
waste	500.000 tons of construction and demolition waste (excluding domestic refuse), assuming 25 million tons of construction waste at 98% recycling	0 tons of construction and demolition waste	source: Letter to parliament 'More value from waste' Closing the loop means 'the end of waste' and therefore the lack of waste
employment opportunities	400.000 working years in the construction sector	increase in employment opportunities	source: EIB 2012 In 'If deconstruction were fully integrated into the U.S. demolition industry, which takes down about 200,000 buildings annually, the equivalent of 200,000 jobs would be created'.
Capital requirement building user	total building and land costs burden the user with the balance (in case of ownership)	annual user charge to producers and landowner, lower than the current rent, by maintaining material value	
SOCIAL IMPACT			
health	Negative impact on welfare users as a result of biological and chemical pollution, as well as inadequate ventilation ('Sick Building Syndrome')	decrease in health complaints as a result of the elimination of chemical pollution	source: US Environmental Protection Agency (1991)
education	-	improvement in training required, including design for reuse	

Although the table is based on an ideal picture, it indicates that the circular economy offers advantages for environmental, economic and social aspects in the construction sector. Nevertheless, the comparison between linear and circular is non-balanced. It labels and generalizes the current utility construction as linear and predicts an ideal 'circular' final image. Also, some themes are underexposed, such as national consumption of building materials and damage to ecosystems from mining. The circular economy is an ideal image, various initiatives have already been taken in the construction but the construction sector is still far from circular.

Various reasons (table 3) are discussed in the literature which indicate why the current way of building is not future-proof and why it is necessary that the construction sector need to move towards a CE (Circle Economy & ABN-AMRO, 2017).



Table 3 - Reasons to move towards a CE (Circle Economy & ABN-AMRO, 2017)

Reasons	Source
The construction sector is by far the largest consumer of raw materials worldwide: nearly half (41 billion tonnes) is being extracted from the ground annually for this sector (mainly minerals and ores).	(Tukker et al., 2013; Wood et al., 2015)
The impact on people and the environment is great. The construction sector accounts for a quarter of the total CO2 emissions worldwide	(International Energy Agency, 2013)
Demand for raw materials in general and building materials in particular is increasing, particularly as a result of urbanization and the growth of megacities in countries such as China and India.	(Krausmann et al., 2009; OECD, 2015)
Materials become scarcer and price fluctuations are bigger. As a wholesale customer for infrastructural projects, China now determines the price of metals and some rare earth metals on the world market.	(Burtton, 2017; Jamasmie, 2016)
With the current way of building, materials already are 'lost' in advance. The linear design and use of materials in buildings ensures that only down-cycling, incineration or landfill is possible during demolition.	

So, there are various reasons why the construction sector need a transition towards the circular economy (CE). As described in section 2.2.3 this transition to the CE takes place in two areas, namely in the field of **design, technology and logistics** and the second one reflects on **the business models for circular economy**. The transition needs to be supported and the required changes in technology need to be stimulated and guided. These systemic changes will only occur when supported by business models and enabled by consumer behaviour, legislation, flows of money/finance, and education. If these enablers have the same goal and work together, they can strengthen each other and accelerate the transition. The aforementioned actors can be seen as the roots of the 'circular economy tree' through which it can grow (FinanCE, 2016).

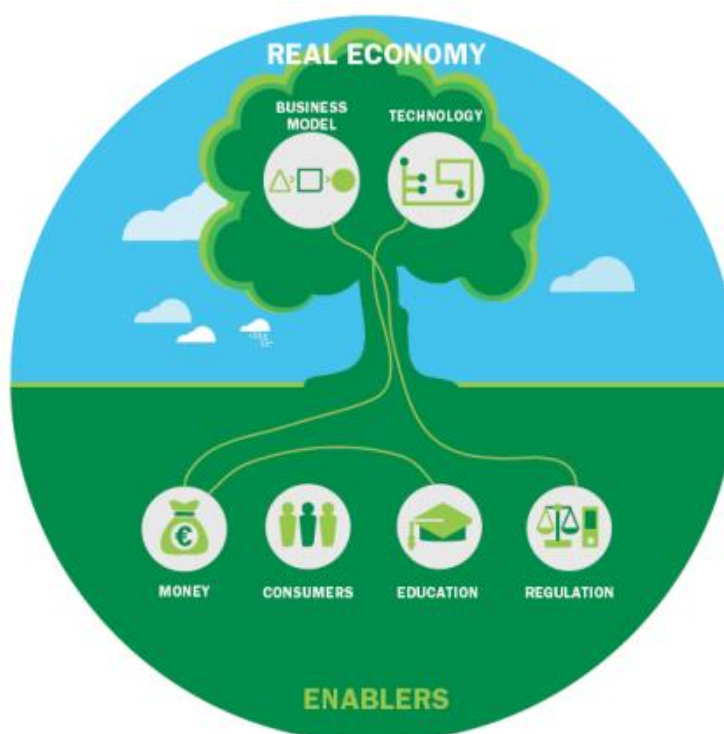


Figure 4 - Enablers of the transition to circular economy (FinanCE, 2016)

2.3.1 Changes in design, technology and logistics

In terms of technology it is important for the transition from a linear to a circular construction sector to design buildings of the future, according to circular principles and with circular materials. Buildings need to be designed and built differently, and the focus is on the reuse of materials and components.



Central to this is the approach to the biggest bottlenecks in the construction chain (S. van Odijk & F. van Bovene, 2014):

- Loss of valuable energy-intensive and high-quality raw materials;
- Low-grade recycling of these raw materials (down-cycling);
- Use of non-durable materials.

In a circular construction sector, buildings are designed according to circular principles (section 2.2.2.) In addition, circular, innovative building materials are used. This implies changed structures of ownership and end-of-life scenarios for building materials.

Design for disassembly, reuse and adaptation

Circular design means that a building consists of dismantlable components. The raw materials for this should be easily recyclable. Disconnecting structural and architectural elements also enhances the adaptability of a building. Table 4 gives an overview of possible circular design principles:

Table 4 - Overview of possible circular design principles (Circle Economy, 2014)

Principle	Explanation
Modular Building	With prefabricated components, such as wall, wall and ceiling panels. When suppliers precisely tailor these parts, the material loss on the building site is minimized. The assembly is also easier and you can integrate the components with insulation or wall coverings.
Extending life-time	By means of (among other things) ventilation and drainage you protect materials from wind and weather.
Anticipative buildings	A building need to be able to change function over time, or adapt to a changing demand or need of the user. Making assets multifunctional, creates a more robust business model behind the investment. This also applies to infrastructural construction.
Standardised dimensions	For example, for the span and heights of structural components. This ensures reusability and a higher residual value of structural structures and materials.
Separate constructive elements from the coating	This increases the adaptability of the construction. It is important to pay attention to the design of the structural structure, so that the architectural features and characteristics of a building can be changed if they no longer fit.
Use detachable components	Permanent connections often result in an irreversible combination of materials. As a result, the re-use opportunities of both the materials and the compounds themselves are greatly reduced. Therefore, it is important to use components with connections that are strong enough to handle one or more (dis) assembly steps.
Building with reusable components, recycled or renewable raw materials	The negative impact of the Building sector largely takes place in the material use phase. This includes energy consumption, extraction, production and transport. With all the ecological effects, such as harmful emissions. That is why the reduction of the demand for building materials is the greatest priority.



Circular building materials

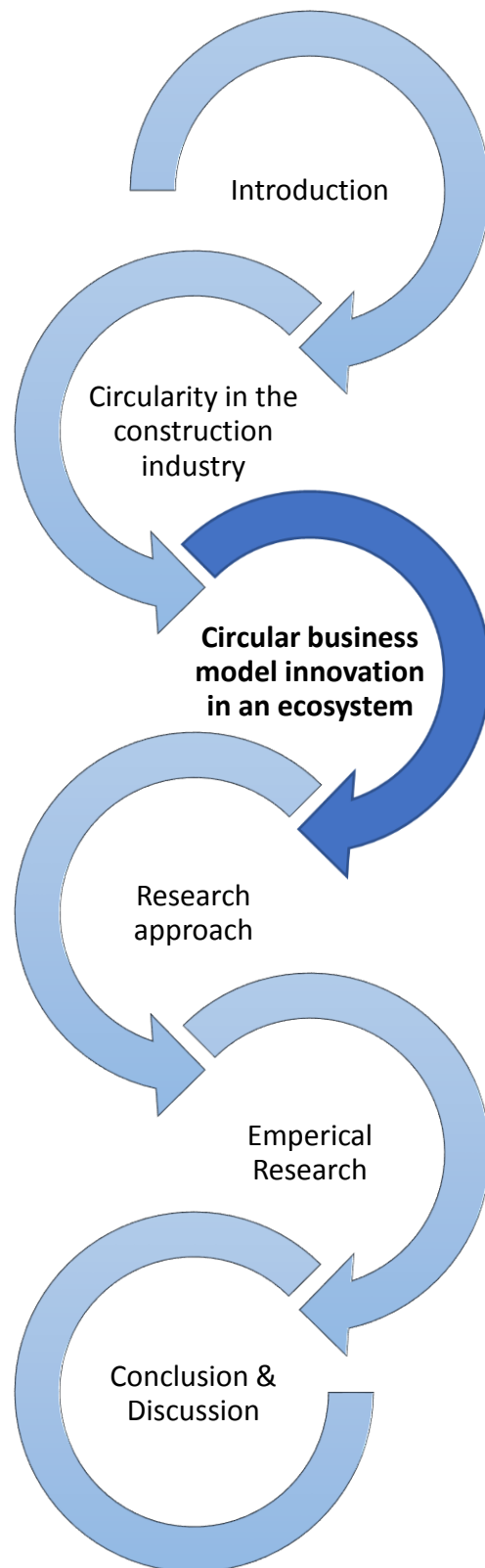
A conscious choice for materials is needed to lower lifecycle impacts, increase the lifespan of materials and enhance reusability and recyclability. Using circular materials will save costs and the materials will even have a positive residual value. Options for circular material usage are listed in table 5.

Table 5 - Overview of options for circular material usage (Circle Economy, 2014)

Principle	Explanation
Reduce material mass	Mass can be reduced by using less robust structures like steel framing instead of heavily built concrete or wooden structures.
Eliminate toxic & non-degradable materials	Many building materials contain toxic substances that are not biological degradable and are harmful to people and the environment. There is a growing number of harmless materials like paints, bricks or cements.
Increase lifespan of materials	Materials like steel and concrete have long lifespans in principle, but weather influences can reduce this lifespan considerably. By using remote sensing for instance, maintenance demands can be monitored and acted upon. Application of high-quality materials is also an important condition for the residual value during renovation or End of Life.
Improve building Performance	Thermal performance for instance can be influenced by material usage. Green roofs for instance can keep water and cool buildings while facades with algae can generate energy and provide shade.

2.3.2 Business models for circular economy

The second area reflects on the business models for circular economy (CE). The required changes in design, technology and logistics for a transition to a CE will only occur when supported by business models. Section 2.3.1 explained what is meant by the necessary changes in the field of design, technology and logistics for circularity in the construction sector. This research focuses more on the second area, the business models for circular economy. The process of circular business model innovation (CBMI) in a business ecosystem has been investigated. A business ecosystem is a network of companies who co-evolve opportunities for new innovations. This is discussed in more detail in chapter 3.





3. Circular business model innovation in an ecosystem

In this section a definition and the concept of a circular business model (CBM) and circular business model innovation (CBMI) are given and explained, based upon a definition of a business model (BM) to ultimately establish success factors of a CBMI in an ecosystem.

3.1 Business model

There is no unambiguous concept about what a business model is and what components it, but there are similarities in the various definitions and concepts. The essence of a business model is to determine how the company delivers value to customers, tempts customers to determine value and converts these payments into profits. Van Loon (2013) concludes that the researched studies use different definitions for business models, but that there are also important similarities (elements).

Elements business model

1. **Creation of customer value:** creating customer value is discussed under various terms such as "value creation design," "value proposition" or "creating value," but the main content of these terms are the same: the business model explain how the company creates value for its customers.
2. **Profit:** a business model should explain how a company deals with costs and how profit is made. Various Business Model definitions report gains in terms such as "profit potential", "earnings model", "revenue logic," "value retention," "profit formula," or "return for shareholders"
3. **Externally oriented:** the business model must also be externally oriented. In addition, the various studies also highlight the relationships that the company has with the various actors in the value chain.
4. **Resources, processes and competences:** it can be concluded that an extensive business model framework must also illustrate the resources, processes and competences as the basis of the company. These are discussed with terms such as "core competence", "resource", "active" or "processes", "activities".
5. **strategic decisions, choices and principles:** these decisions are discussed under terms such as 'target market ', 'customer target group ', 'position within value network, 'competitive strategy,' or 'rules'

According to Osterwalder & Pigneur (2010) a business model describe the rationale of how an organization create, deliver, and capture value. Osterwalder & Pigneur (2010) have developed a tool for organisations to create their own business model. The tool consists of nine keystones which can be related to the above mentioned five elements. The nine keystones together form the well-known, business model canvas (figure 5).

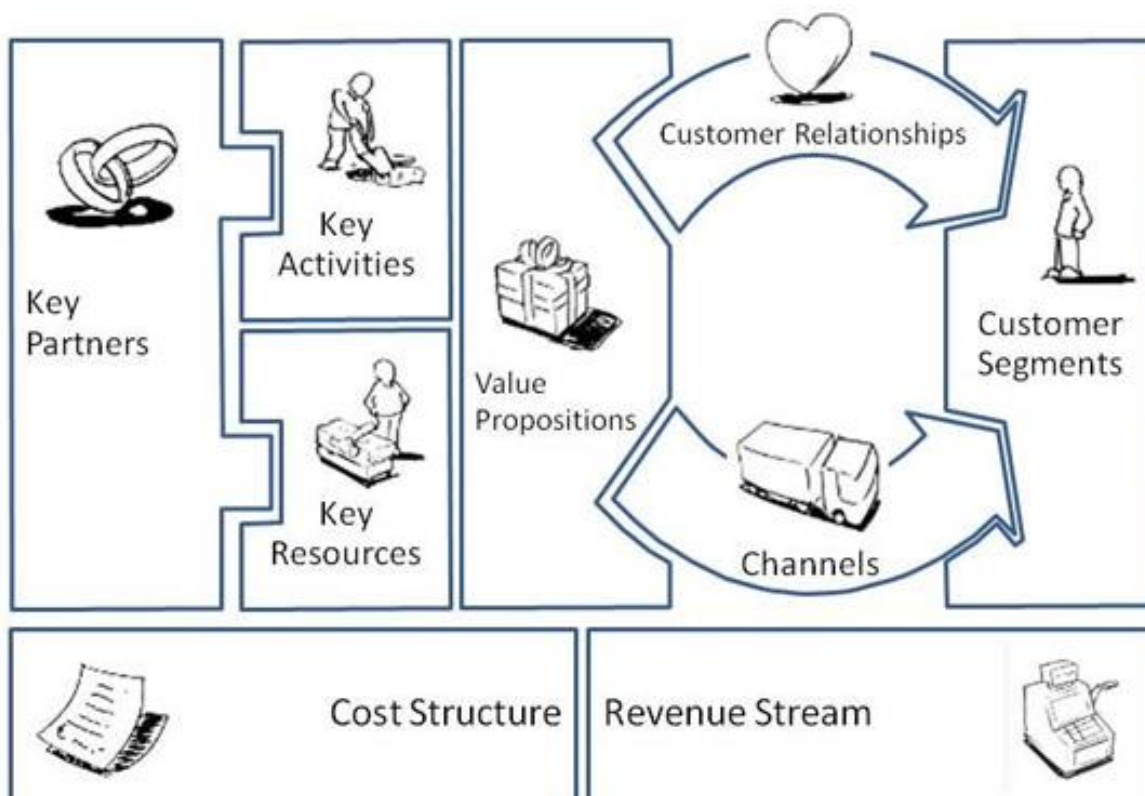


Figure 5 - Business model canvas: the nine keystones of a business model (Osterwalder & Pigneur, 2010)

Both, the elements and the business model canvas are related to the four pillars of a business model. This breakdown is most widely accepted in literature (Mentink, 2014):

1. Value proposition: **what** value does a company create with its product/service
2. Infrastructure management or supply chain: **how** is the value proposition created, including the structuring and management of upstream relationships with;
3. Customer interface: **who** are the customers, including the structuring and management of downstream relationships with these customers (delivery of value);
4. Financial model: costs and benefits from 1),2) and 3) and their distribution across BM stakeholders (**why** is the value proposition created)

3.2 Circular business models

The transition from the linear to the circular economy will have an impact on the business model, because business simply cannot meet the requirements of circular concepts. Therefore, new circular business models (CBM) are needed which close cycles, create collective value and which shares these values. The difference between a business model (BM) and a circular business model (CBM) is that a CBM should be regarded as a subcategory of BM's which fit in an economic system of restorative or closed material loops (Mentink, 2014).

But, what exactly is a circular business model? According to the literature review, Mentink (2014) defined a circular business model as follow:

"a circular business model is the rationale of how an organization creates, delivers and captures value with and within material loops" (Mentink, 2014)'.



Several studies on circular business models (CBMs) have recently been published. These studies can be classified on the one hand by **characteristics** and on the other hand by the **building blocks** of these business models. Business models for the circular economy are characterized by: (J. Jonker, 2016)

1. Closing raw material chains;

Within the circular economy, closing raw material chains is a central principle. By closing a chain or keeping a chain closed, raw materials do not become waste.

2. Transition from products to services

Within the circular economy there is a shift from products to services. By designing products as services, in whatever form (rental, lease, loan), the producer remains the owner and it is in his interest to produce sustainably to reduce maintenance costs.

3. Better use of the functionality of the products.

Within the circular economy, products and the resources are used more and more intensively. In other words: the functionality of products is better utilized. Walter Stahel - one of the Godfathers of the circular economy - writes about this in an article from 1982 'The economic objective of the functional economy is to create the highest possible use value for the longest possible time while consuming as few as possible material'. This means that we are actually looking for the best possible use of functionality (J. Jonker, 2016).

The above mentioned characteristics of CBM and the five elements of a BM can be translated into a number of generic **building blocks** which can be characterized for all circular business models: (J. Jonker, 2016)

1. Realization of cycles;

The core of the circular economy (CE) is the closing of (material) cycles or keeping this cycles closed in the production process and in the life cycle of a product. This is possible within the own organization, but also with parties in the value chain.

2. Striving for value creation;

By working on the basis of principles of the CE, more than only financial value is created. It is also about creating social and ecological value.

3. Choose an appropriate strategy;

Being able to be successful with the CE requires choosing a clear strategy, aimed at the organization of circular entrepreneurship. Business models for the circular economy must make other strategic considerations in which long-term relationships with one or more customers for a product are important.

4. Design an organization that fits with the between-parties-organization

The CE asks to organize together with partners in networks; no company can only operate in a circular way. Organizing multiple value creation in conjunction and in collaboration is a condition for a business model for the circular economy.



5. Developing revenue models

By organizing circularly, the revenue models change. Turnover is made, among other things, over time (lease or performance models) or by creating value with each other (cascading).

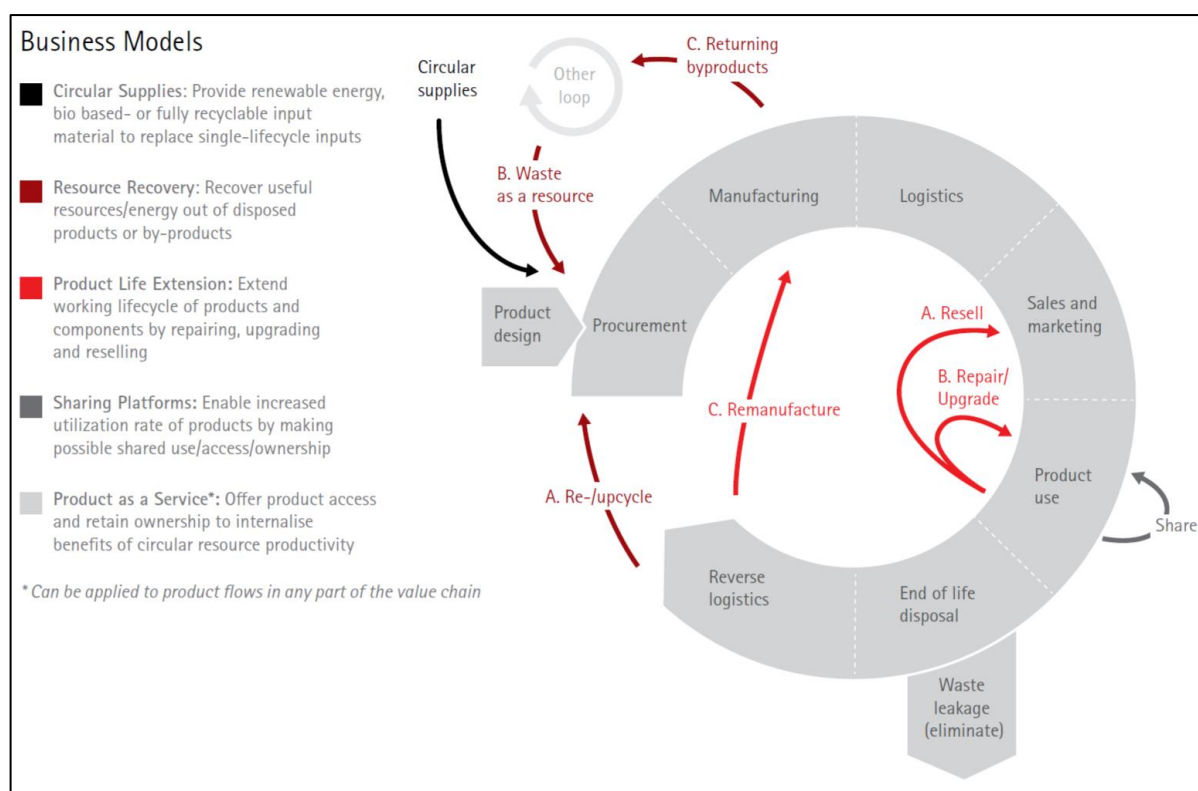


Figure 6 - The five circular business models (Accenture, 2014)

Accenture (2014) identified in its analyses five circular business models (CBM) which are shown in figure 6. These CBM can be related to the characteristics and building blocks of CBM which are described in section 3.2. These CBM have their own distinct characteristics and can be used singly or in combination to help companies achieve massive resource productivity gains and, in the process, enhance differentiation and customer value, reduce cost to serve and own, generate new revenue, and reduce risk.

A circular business model (BM) does not have to close any material loops (within the internal system boundaries), but can also form part of a business model system that together closes a material loop to be called circular. Figure 7 shows an example of such a system in which different business models conclude a material loop. For example, BM 1, 2, 3 and 4 in figure 7 together close the blue material cycle and could all be regarded as circular business models (other material flows left aside). BM 6 and 7 are regarded as non-circular, because they are not part of any material cycle.

Circular business models ensure that materials remain in the economic system and they also enable other companies to do so. The latter means that if a company makes products from recycled materials, but in such a way that it is too difficult to recycle the materials again, the company in fact impedes a closed material loop. In Figure 7, BM 6 can represent such a company. Therefore, regarding the system, it is indispensable to determine whether a BM is circular or not. BM 2, 3, 4 and 5 are part of the large transitional or 'gray area' or BMs which are circular to a certain extent.

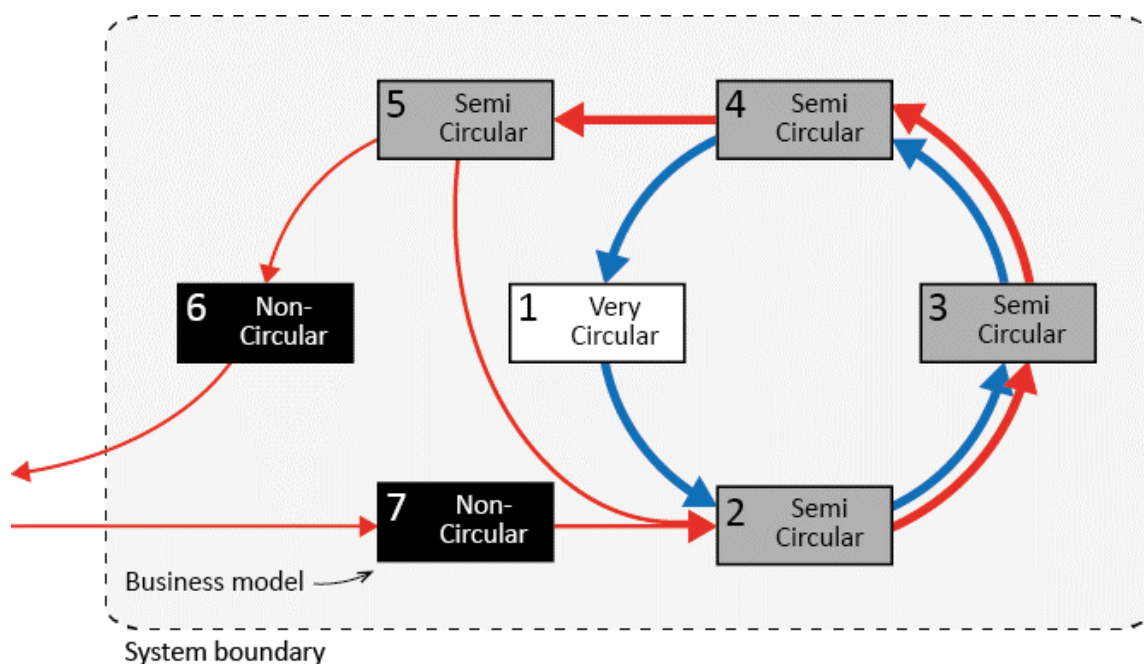


Figure 7 - A system with circular, semi- and non-circular business models (Mentink, 2014)

The need for BMs in order to implement CE has been widely expressed and is regarded as one of the key obstacles for successful implementation of CE (EMF, 2015). These so-called CBM can be implemented through the CBMI-process. The goals and scope of a CBMI process can vary greatly because CE targets at company level differ from the targets at system level. The research of Mentink (2014) focused on improving the concepts for CBMs during CBMI processes at company level. This research focuses on CBMI processes at the analysis level of the entire system, called the business ecosystem because firstly, there is a gap in the literature where studies connect both concepts and provide insight into the process of circular business models innovation at the level of analysis of the business ecosystem. Secondly, good cooperation between parties and in a network is an important aspect for the transition to the circular economy. Research at the analysis level of a business ecosystem will ensure a broadly supported transition in which small circles (at company level) are extended to larger circles (business ecosystem level). Section 3.4 will address these business ecosystems in more detail. First, circular business model innovation will be discussed in the next section.

3.3 Circular business model innovation

Parties in the construction sector can change their role in the sector by looking at new business models or innovating the current business model to promote the transition to the circular economy. We call this circular business model innovation (CBMI). In this section, insight will be given into what CBMI is. First an introduction will be given on business model innovation (BMI) to understand the principle. Next, the CBMI, its criteria, and the different phases of a CBMI will be discussed.

3.3.1 Business model innovation

Business model innovation (BMI) can be defined as a new way to create and capture value, which is achieved through a change of one or multiple components in the business model (K. Frankeberger, T. Weiblen, M. Csik & O. Gassmann, 2013). These components are the nine keystones of a business model (see figure 2). BMI create new opportunities to participate in economic exchanges and focuses on the four pillars of the BM (section 3.1). It has been widely acknowledged, BMI is a key source of competitive advantage, either by supporting the strategic marketing of innovative processes, products and services (Mentink, 2014). Consequently, managers consider business model innovation to be more important



for achieving competitive advantage than product or service innovation (K. Frankeberger, T. Weiblen, M. Csik & O. Gassmann, 2013).

To perform BMI a company has to go through a specific process with distinct phases. Frankenberger (2013) have developed a framework based on a literature study on innovation process models and experiments which consist of four generic phases. These four phases in the BMI process are:

- **Initiation or analysis phase;** the current business environment is analysed for changing in stakeholders (and customers) needs and other drivers.
- **Ideation phase;** generating new ideas by thinking creatively.
- **Integration phase;** the ideas from the previous phase are further elaborated in complete BMs.
- **Implementation phase;** this phase includes all necessary processes of alignment and acquisition means to study the new BM.

BMI process is an iterative process and goes several times through the phases when more information is added. Some strength characteristics of BMI are; (1) Structuring and understanding a firm's system or network of activities, stakeholders and interrelations (the "activity system"). (2) Achieving higher degrees of innovation by looking beyond traditional sets of partners, competitors, and customers. (3) A holistic perspective on a business allows for optimization of the whole instead of individual activities. (4) Finally, BMI is recognized as an operational way to implement CE in practice (Mentink, 2014).

3.3.2 Circular business model innovation

According to Mentink (2014) circular business models do not need to close material loops within its internal system boundaries, but can also be part of a system of business models that together form a material loop to be considered 'circular'. This is where the principle of CBMI is introduced because the network plays a central role. CBMI requires cooperation, communication and coordination within complex networks of interdependent but independent actors / stakeholders. The re-design of business ecosystems is the big challenge in CBMI because a win-win situation should be created that balances the interests of the actors involved and therefore influences and facilitates their actions in order to give shape to the circular business model in a coordinated way.

As described in section 3.3.1., Frankenberger (2013) developed the 4I framework for BMI. Subsequently, Mentink (2014) adapted / extended the 4I framework to a CBMI framework so that it can be used for circular BMI. This framework consists of 4 phases in which the challenges for CBMI are described. Figure 8 is a schematic representation of this CBMI framework. This figure shows the process and challenges of CBMI per phase. For example, it can be seen that thinking in systems in the initial phase is a big challenge. The central theme of the initiation phase is the analysis of the 'business ecosystem' (discussed in section 3.4.) or business system the company or companies are part of. Therefore, thinking in systems is the first important challenge for companies (Mentink, 2014). Thinking in systems is also part of BMI but for CBMI the whole supply chain needs to be regarded, which requires to think in systems on a higher level. In all four phases of the CBMI framework, this challenge is directly or indirectly very important. Below, challenges which can be related to thinking in systems on a higher level are mentioned:

- **Initiation phase:** think in systems, is the big challenge in this phase. Analysing the business ecosystem where the companies are part of.
- **Ideation phase:** think in business systems. Companies should think beyond their own BM to generate ideas for the entire supply chain.
- **Integration phase:** the challenge in this phase is to involving partners and ensuring their support and coordinate the collaboration with partners throughout the system.



- **Implementation phase:** in this phase, organization or partnership needs to collectively identify a leader to become the main problem owner and guide the implementation process.

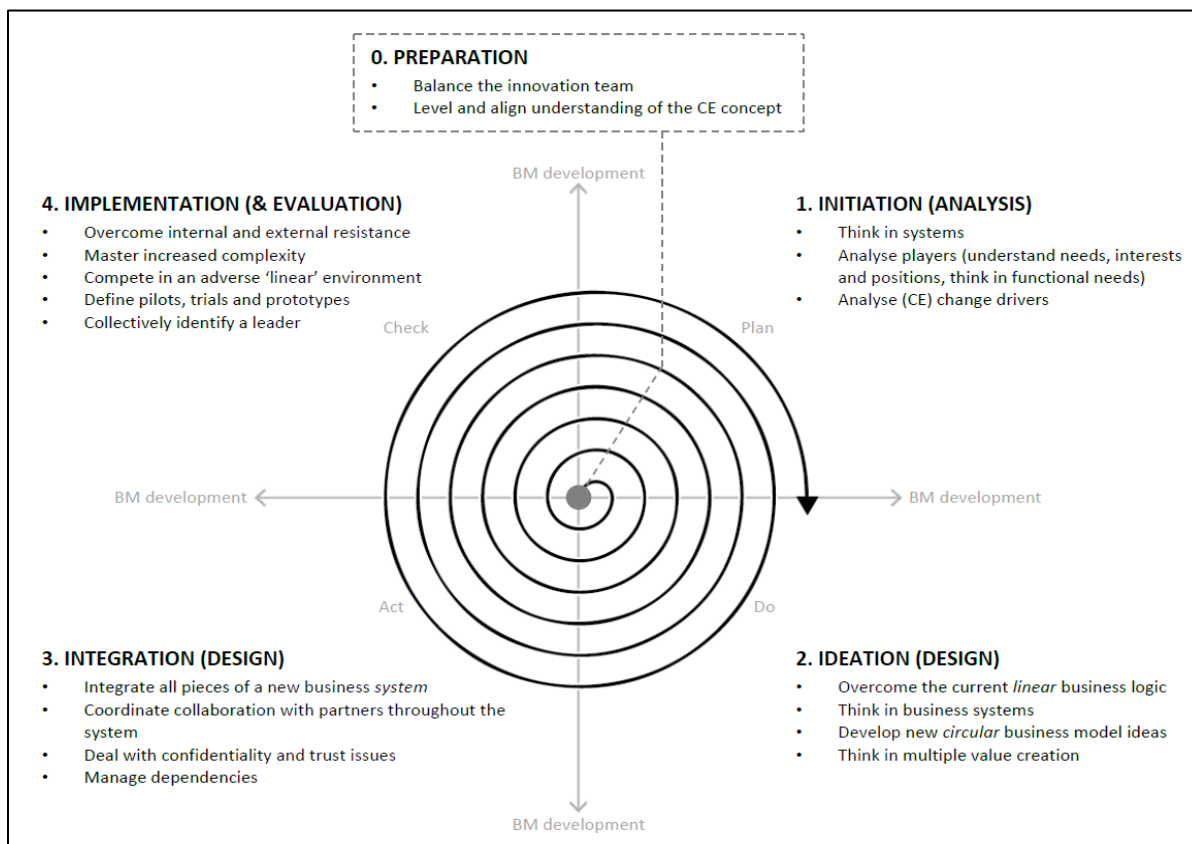


Figure 8 - CBMI framework (Mentink, 2014)

3.4 Business Ecosystems

The explanation of CBMI's challenges in section 3.2 shows that thinking in systems on a higher level, business eco-system level, is very important. In this section, a definition will be given of business ecosystems, what means an innovation of a business ecosystem and the possible success factors for CBMI in a business ecosystem.

3.4.1 Introduction Ecosystems

Companies are increasingly being given the opportunity to build benefit by joining together in networked ecosystems or Business Ecosystems. This creates new opportunities for innovation alongside new challenges for many incumbent enterprises. Business Ecosystems are larger, more diverse and more flexible than a traditional series of partnerships or working with outsourcing partners. By using ecosystems, companies can deliver complex solutions while maintaining focus on the company.

An ecosystem finds its origin in nature. The word was invented in 1930 by the British botanist Arthur Tansley to refer to a localized community of living organisms interacting with each other and their specific environment of air, water, mineral soil and other elements. These organisms influence each other, and their terrain; they compete and collaborate, share and create resources, and co-evolve; and they are inevitably subject to external disruptions, to which they adapt together (Eamonn, 2015).



The strategist James Moore noticed growing parallels and imported the concept into the increasingly dynamic and interconnected world of commerce. As he wrote in a 1993 Harvard Business review article:

Successful businesses are those that evolve rapidly and effectively. Yet innovative businesses can't evolve in a vacuum. They need to attract all kinds of resources and attract capital, partners, suppliers and customers to set up cooperative networks . . . I suggest that a company be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries. In a business ecosystem, companies co-evolve capabilities around a new innovation: They work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations (Moore, 1993).

Moore's insight was progressive and in the future more and more companies will be subject to the advantages of the eco-system strategies in relation to those who focus on the activities in vertically integrated organization or trust in traditional outsourcing. By introducing an eco-system strategy, companies can respond to the global trends / problems. The necessity of the transition to the circular economy arose from such a global problem that has been discussed in the problem definition (section 1.1). A well-known example of such an ecosystem is the 'Shanzhai-ecosystem' where cooperation agreements have been made between hundreds of companies that accelerating entrepreneurial innovation in areas such as smartphones and the next generation of smart watches.

3.4.2 What are Business Ecosystems?

In a business ecosystem, companies co-evolving opportunities for new innovations. They work cooperatively and competitively on new products / services. According to Moore (1993), companies are not considered to be members of an industry but as part of a business ecosystem that can cross several industries. The ecosystem offers a new framework and a new way of thinking that establishes a profound change in the economy and the business landscape. The importance of relationships, partnerships, networking alliances and partnerships grow.

Lansiti and Levien (2004) and Zott (2011) argue that it is impossible to sketch the exact limits of an ecosystem. Instead, you should try to systematically identify the organization that will be most closely interwoven in the future and determine the dependencies that are most crucial to a business.

Despite the fact that it is difficult to sketch the exact limits of business ecosystems, there are three important aspects that make up a business ecosystem:

- **Symbiosis;** Business ecosystems have a loose network of suppliers, distributors, outsourcing companies, makers of related products or services, suppliers of technology, and many other organizations (M. Lansiti & R. Levien, 2004). So, symbiosis indicates partners of a loose network with synergic and systematic cooperation;
- **Platform;** A "platform" of services, tools, or technologies that other members of the ecosystem can use to improve their own performance, meaning the value of a business ecosystem shifts from product to network (Moore, 1993).
- **Co-evolution;** Ecosystems evolve participants to a new landscape. Business ecology implies a broad community of companies and individuals who add value to a technology standard by supplying complementary assets to the core product. Co-evolution demonstrated different roles such as keystone, niche and dominator which cooperated and were complementary to one another with the purpose of mutual benefit (Moore, 1993).



Having noted the concept of business ecosystem and the aspects, it is important to clarify how it is used in this report: *Business ecosystems are dynamic and co-evolving communities of diverse actors who create and capture new value through ever better collaborations and competition.* This definition allows for the fact that ecosystems come in a broad array of shapes, sizes, and varieties. Also, it captures three core characteristics that are generally present and also related to the aforementioned aspects. First, ecosystems create and stimulate the participation of large and small organizations (**Symbiosis**), and often individuals, who can create, scale and serve markets that go beyond the capabilities of a single organization (from a group of broadly similar actors). In some cases they relate to major social problems that no individual organization can solve. This also applies to the exhaustion of our natural resources. As described in the introduction (section 1.1), the construction sector has a major impact on our environment and is inextricably linked to the (over) exploitation of raw materials as a strategic sector for the global economy. Therefore, the presence of a symbiosis is necessary for a transition to a circular construction sector.

The second characteristic is that actors that are part of the ecosystem communicate and co-create in ever more sophisticated ways by using technologies and tools of connectivity and collaboration that are still proliferating and disseminating (**platform**). This means that in the coming years there will be momentum for an increasingly productive ecosystem development.

Thirdly, participants / customers are connected through a combination of shared interests, goals and values that encourage them to collectively nurture, sustain, and protect the ecosystem (**Co-evolution**). Everyone contributes because everyone benefits. This enhances the longevity and durability of ecosystems (Eamonn, 2015).

3.4.3 Innovation in Ecosystems

Innovation in alliances and networks is gaining in popularity, but it is very difficult to gain control of such an innovation-ecosystem because many parties are involved. Especially governments and network organizations that want to stimulate the ecosystem experience this complexity. In addition, the nature of innovation is changing. Trends such as technological disruption, the rise of corporate venturing and entering into alliances mean that innovation must increasingly take place within chains or networks, and not just within the walls of a single organization (Consultancy, 2016). This also applies to the current transition to the circular economy that can be considered in this context as the innovation in question. The process of such an innovation consists of three phases, namely; phase one the emergence of an idea and phase two the development. Important in phase two is the transformation from the idea to product / service. And as final phase 3 the implementation. In this phase, the institutionalization of the product or service is important (the broad acceptance of the innovation) (Garud et al., 2013).

PHASE 1 IDEA

The periods for the emergence of new ideas are generally very long and also cause changes in the system. The process of creating a new idea is not easy and is characterized by setbacks. In addition, this period is also characterized by ongoing and shifting evaluations of progress, and by involvement of stakeholders engaged in the development of a network. Most innovation processes do not have real fixed steps but are characterized by repeated cycles of divergent and convergent phases. Divergence is driven by investment of resources (people, time, ideas and money) on top of the normal investment of the system. Convergence is caused by exogenous factors, such as institutional rules and organizational mandates, and endogenous factors, such as resource constraints and the discovery of opportunities to attract attention (Garud et al., 2013).



PHASE 2 DEVELOPMENT

Both the emergence and the development of an idea is very challenging. The processes in the phase are disordered, with actors involved in other processes, such as improvisation and experiment. In addition, even the most interesting new ideas are confronted with inertia and resistance, making it very difficult to give an innovation the necessary impetus. Ultimately, there are also ideas that evolve from conception to commercial development when the innovation process starts (Garud et al., 2013).

PHASE 3 IMPLEMENTATION

When the potential feasibility of an idea is demonstrated, it doesn't mean that the benefits can be utilized. It only means that these innovations represent hopeful debutants. A lot of steps still have to be taken before the innovation really has a good basis, a broad implementation and being part of a broad-based use / production (Garud et al., 2013).

3.5 Circular business model innovation in a business ecosystem

The previous section provided insight into the different phases of innovation of a business ecosystem because these phases form the basis on which certain success factors can influence. In this section the two most important concepts will be brought together, namely; circular business model innovation (CBMI) and business ecosystems. An overview is given of success and failure factors that play a role in circular business model innovation (CBMI) in a business ecosystem. Although small, unambiguous literature is available on CBMI in a business ecosystem, an attempt has been made to provide answers to the potential success and failure factors from the existing literature. The results from the study of van Loon (2013) form the basis for defining the success and failure factors for CBMI in a business ecosystem.

3.5.1 Success and failure factors

The success and failure factors of CBMI in an ecosystem differ from CBMI in a company. This because of a different perspective and level. CBMI in a business ecosystem is not focused on one company but on the whole system. This causes a different dynamic and other factors that are important for CBMI. The factors which are described by van Loon (2013) are the requirement of (1) a Lead company, (2) trust and control, (3) strategic thinking, (4) absorption capacity and (5) interdependence, in an ecosystem, of the business model. Van Loon's research focuses on business model innovation (BMI) and in this research the focus is on circular BMI. The major difference between CBMI and BMI innovation is that CBMI is a social problem that emphasizes the necessity of the transition to the circular economy. It is not the case at BM and it concerns, for example, a question from the market where a BMI takes place to make profit. Five success factors as described by van Loon (2013) are substantiated in this research from the perspective of CBMI, which means that additions or changes have been made. These changes and / or additions were made on the basis of various studies. In addition, it will indicate for each factor at which phase (idea, development or implementation) of the innovation process they can affect.

Factor 1: Requirement of a Lead Company

A lead company is important in stimulating and shaping the business ecosystem. The lead company is not necessarily the largest or most resource-rich participant, but this company is important for the concept of an ecosystem. The lead company should have an active role by first highlighting the potential for value creation for the end customer. Secondly, the lead company must structure the differentiation of partner roles. This allows the lead company to keep the burden of partner interaction



at a manageable level. Third, the Lead company must encourage complementary partner investments. Fourth, the company acts to reduce transaction costs by creating mechanisms such as trust and knowledge sharing. Finally, it must create flexible structures that can promote co-learning while protecting its own value mechanisms. The sum of all these actions defines a lead company in a successful ecosystem. "The keys of ecosystem advantage" (P. J. Williamson & A. de Meyer, 2012)

Lead companies are also called keystone organizations. They can increase the productivity of the ecosystem by simplifying complex tasks, such as connecting network participants or creating new products by making third parties more efficient. In addition, 'key' companies can create value for their ecosystems in many different ways, but often the creation of a platform is a requirement. This platform can offer an advantage in the form of services, tools, or technologies that provide solutions for others in the ecosystem. The platform can be a material / material asset (M. Lansiti & R. Levien, 2004). Think of platforms like Madaster. This is a cadastre for materials in which materials are given an identity with the help of the materials passport, reducing the likelihood that they will disappear as waste (Madaster, 2018).

For a successful circular business model innovation (CBMI) within a business ecosystem it is necessary that the lead company points to the potential of value creation. The logic of value creation in the circular economy is as Walter Stahel (1982) wrote in his article; *'The economic objective of the functional economy is to create the highest possible value for the longest possible time while consuming as few as possible material'*. The core of the value creation of the circular economy is based on a number of principles: (1) Use raw materials / material as long and carefully as possible, whereby (2) the service (the performance) replaces the product, and if things are still worn then (3) the raw materials from which a product consists can be used as raw material again. This creates new business models based on closed cycles. Accenture (2014) proposes five business models for circular economy, namely; (1) circular supplies, (2) resource recovery, (3) product life extension (4) sharing platforms and (5) product as a service (figure 6). These circular business models are very interesting but also limited because of the lack of information about the (integral) value creation. Therefore the question is how this can be organized but does not fall within the scope of this research.

As mentioned earlier, it is necessary that the lead company points to the potential of value creation, creating the right to exist for CBMI. This plays in phase one: THE IDEA. When there is a right to exist, the lead company can attract partners who will contribute to the process of a successful CBMI. This plays in phase one; IDEA and phase two; DEVELOPMENT. Subsequently, the distinction between partner roles must be structured in order to obtain successful CBMI. This also plays a role in phase one; IDEA and phase two; DEVELOPMENT. In addition, the Lead company has a role in creating and promoting mechanisms such as trust and knowledge sharing, reducing transaction costs. This plays a role in phase two; DEVELOPMENT and phase three; IMPLEMENTATION. Finally, the Lead company must promote co-learning and will play a role in phase two: DEVELOPMENT and phase three: IMPLEMENTATION.

Therefore, a lead company is an important factor in all three phases (idea, development and implementation) of the innovation process, but the tasks differ per phase. The loss of a lead company will, in most cases, mean the collapse of the entire ecosystem (M. Lansiti & R. Levien, 2004).



Factor 2: Trust in partner collaboration

Also 'soft' factors such as expectation and trust form the cooperative relationship and thus partly determine the degree of success of a business ecosystem. A high level of trust creates a context in which all parties can realize their individual objectives and can work towards common objectives, without opportunistic behaviour (NEVI, 2018). There are two alternatives to forming trust in a partnership, namely; trust and control. These alternatives are important for the success of circular business model innovation in a business ecosystem, because a low level of trust not only jeopardizes the formation of cooperation and thus the innovation process, but also leads to suspicion between partners, which has harmful effects on the mutual relationship (T.K. Das & B. Teng, 1998).

Control

Control is an important aspect because companies in a business ecosystem will have more confidence in partner cooperation if they feel that they have an adequate level of control over their partners. Control is " *a regulatory process in which the elements of a system are made more predictable by setting standards to achieve an intended number of goals* " (R. Leifer & P.K. Mills, 1996). Control mechanisms and the degree of control are two important concepts in this case. Control mechanisms are the organizational arrangements to determine and influence what organizational members do. Control is the direct outcome of the control mechanism process. Companies want to use control mechanisms to promote non - routine activities, such as learning to take risks and innovation. There are three important control mechanisms, namely being the first to set specific challenging targets. Secondly, structural agreement, this includes rules and restrictions which is the centre of formal control, and the last one is culture. Culture is formed by values and norms, the challenge is to incorporate the culture of the partners in a balanced way into the cooperation. Cultural collisions are a common cause of the failure of partnerships (T.K. Das & B. Teng, 1998).

Trust

In addition to the aspect of control, trust is a second aspect which is important for trust in partner cooperation. Trust is especially valuable in partnerships because, to varying degrees, companies have to rely on their partners. The concept of trust in partner cooperation must be distinguished from the concept of trust. The most important is that trust refers to expectations about positive motives, while trust in partner cooperation refers to certainty about cooperative behaviour (T.K. Das & B. Teng, 1998). In addition, trust will have to increase when the interests and dependence and the intensity or duration of the collaboration are great. Then, confidence is necessary to cover the perceived risks as much as possible (NEVI, 2018).

Factor 3: Strategic thinking

Strategic thinking goes beyond time, space and resources to come up with innovation solutions and to tackle difficult issues such as the transition to the circular economy (CE). Strategic thinking has some important characteristics, namely; (1) long-term orientation, (2) systematic and integrated approach to problem solving, and (3) creativity (Abraham, in Loon, 2013).

Strategic thinking is important for the success of a circular business model innovation in a business ecosystem, because the challenges and limitations of the transition to the circular economy and learning how these challenges can be translated into targeted actions, requires strategic thinking. In addition, strategic thinking focuses on visualizing the future before it happens, a process that involves building different scenarios such as predictions about future conditions. Also, Strategic thinking requires an integration of divergent viewpoints into a coherent whole. This integration requires



creativity and intelligence. Strategic thinking is a process, in which the connections between the various components are built on. These components form a vision for the future. In addition, it has been shown that transforming this vision is a lengthy process in which organizational resources are necessary to make this transformation possible (Loon, 2013). Because definitions of arena, competition, and competing tools are new, strategic thinking is often associated with radical and revolutionary transitions in the existence of industries and companies (Hamel & Prahalad, in Loon, 2013). If this is analysed in relation to the transition to the CE, it also requires revolutionary transitions in the existence of industries. The current construction industry is in the traditional linear economy, but in order to promote the transition to the CE, revolutionary transitions have to be made in companies and industries, and therefore strategic thinking is very important.

This factor is important in all three phases (IDEA, DEVELOPMENT and IMPLEMENTATION) of the innovation process, because it gives guidance in all phases to the question of how the transition to the CE can be promoted within the Business Ecosystem.

Factor 4: Absorption capacity

Absorption capacity is the ability of a business ecosystem and its participants to receive specific knowledge and to use it efficiently. This can be compared with the capacity of a sponge to absorb liquid.

Social and technological developments have accelerated the pace of change in customer demand and make it difficult to respond to this. Research shows that this is possible by renewing knowledge that is seen as the most important key. Thinking from the concept of 'absorption capacity' can help a business ecosystem and its participants to create the space needed for continuous knowledge development. Take, for example, the previously mentioned sponge that absorbs water. The capacity is then the speed and the amount of water that can be absorbed by the sponge. This is comparable to the inclusion of knowledge (Veen, 2018).

Absorption capacity is important for successful business model innovation (BMI) in a business ecosystem, because the lack of absorption capacity (Cohen & Levinthal, in Loon, 2013) is an impediment to the preparation of ideas in a network of multiple parties. This also applies to circular BMI because it concerns ideas about how to shift from linear to the circular economy in the construction sector. In addition, timing and integration is important in the adoption process. Therefore, it is important that supplements are developed or adopted in time within the business ecosystem to promote the transition to the circular economy.

Absorption capacity will play a role in all three phases (IDEA, DEVELOPMENT & IMPLEMENTATION) of the innovation process. Absorption capacity ensures that ideas are absorbed and this will play a role in phase one; IDEA. In addition, the capacity to absorb the total integration of the various services and products of the participants of the business ecosystem into one integrated business model innovation (Loon, 2013). This plays a role in phase two: DEVELOPMENT. In phase three: IMPLEMENTATION absorption capacity also plays a role because the timely implementation into one integrated product of the business ecosystem depends on the absorptive capacity of the participants of the business ecosystem.



Factor 5: Interdependence / activity system

Interdependence / activity system perspective is the linking of the dynamics of the value creation and its consequences for the determination of the value in a structure of the interdependence in the ecosystem of a company. It is the relative location of the activities within the ecosystem and the different roles of the various actors in the environment of the company (Loon, 2013). Adner and Kappoor (2010) identify roles on the basis of the location where the activities are bundled in the ecosystem. Companies are dependent on each other because they need competences that the other party possesses. In addition, the companies have built up an efficient collaboration.

Van Loon (2013) states that the factor interdependence / activity system is important in the business model innovation (BMI) process in a business ecosystem because it creates a strategy that specifically takes into account the delays and the challenges associated with collaborative networks. The key is to succeed innovation in an ecosystem. When looking at Business Model Innovation for circular economy, it can be stated that collaborating partners within an ecosystem are necessary to create cascades together. Thinking in these cascades is one of the five CE principles (Ellen MacArthur Foundation, 2014).

This factor is important in the third phase: DEVELOPMENT. In this phase of development the activity system takes shape. In these phases the roles of the different parties are identified and the location in the system is determined.

3.6 Conclusion literature review

Companies related to construction sector can change their role in the sector by looking at new business models or renewing the current business model to facilitate the transition to the circular economy. We call this circular business model innovation (CBMI). CBMI can take place at two levels, namely at the company level and at the level of a business ecosystem. Figure 9 gives a visual representation of CBMI at a company level and CBMI at the level of a business ecosystem in order to make the difference in level more clearly. In this study, the focus is on CBMI at the level of a business ecosystem. CBMI in a business ecosystem can be divided into three phases, namely: idea, development, and implementation. In all three phases, several factors influence the success of a CBMI. The success factors or CBMI in an ecosystem differ from CBMI at company level because of a different perspective and level. CBMI in a business ecosystem is not focused on a company but on the entire system. This causes a different dynamic and other factors that are important for CBMI. The factors are the requirement of (1) a Lead company, (2) trust and control, (3) strategic thinking, (4) absorption capacity and (5) interdependence, in an ecosystem, of the business model. The empirical research will be used to investigate the process of CBMI in a business ecosystem. It will be examined which of the above success factors influence the process and in which phase they influence the process. Firstly, in chapter 4 the research approach will be described, after which the results of the empirical research will be explained.

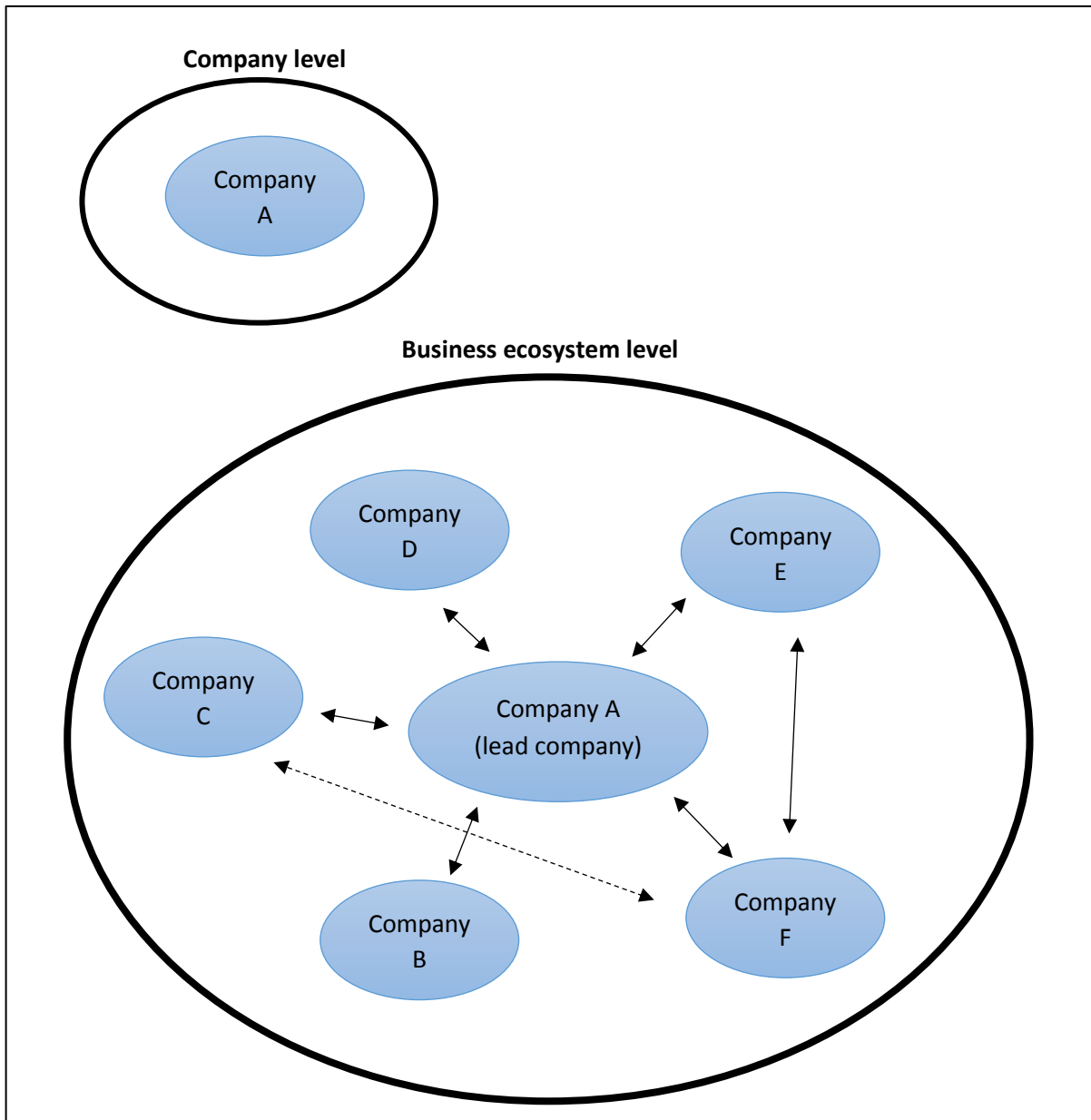
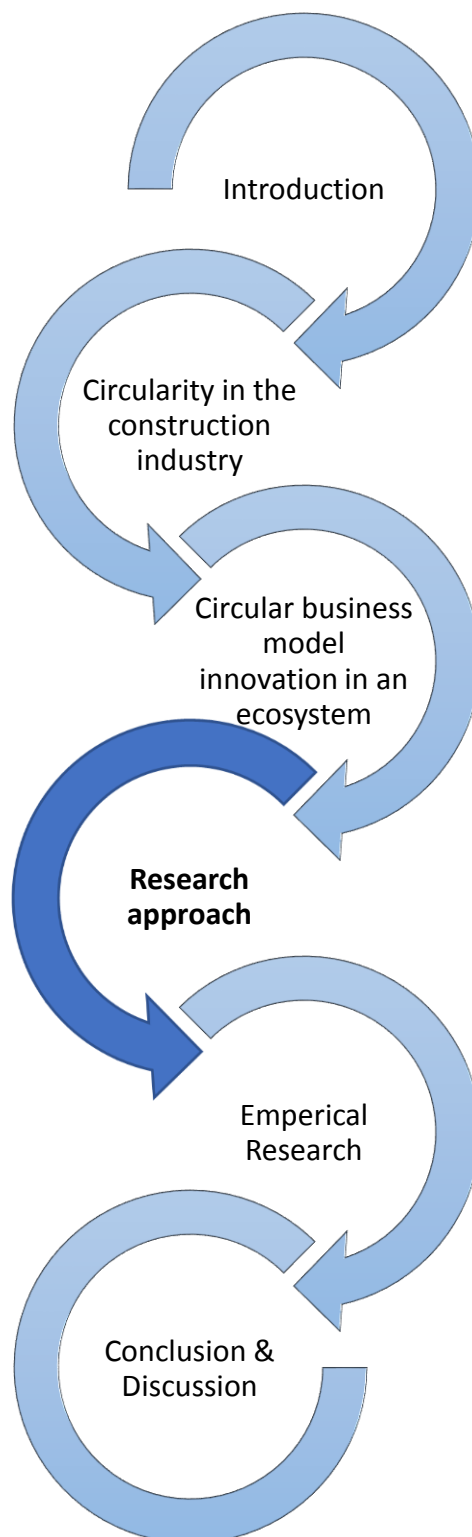


Figure 9 - Different level of innovation (own illustration, 2018)





4. Research approach

4.1 Introduction

This chapter will elaborate the research approach as outlined in the introduction. For this research, a structured single case study design has been set up in which interviews have been conducted. This chapter explains the methodology, the cases and how the data is collected.

4.2 Single Case study

4.2.1 Methodology

For this research, a single case study was chosen. A single case study is research with only one research unit and is qualified as qualitative research. Within a case study, various sources of information are consulted and obtained through different methodologies, namely (Management Platform, 2015):

- **Document research:** this is an effective and systematic way of collecting documents produced by organizations in order to be able to give a description and/or explanation of a phenomenon that is relevant to the topic within the research.
- **Participatory observation:** This is about participating in the social phenomenon in order to observe behaviours, attitudes and activities et cetera.
- **Depth interviews:** The third method in the single case study research is the in-depth interview. This is a conversation between the researcher and a respondent who is involved in the research phenomenon. The purpose of this is to discover experiences, interpretations and experiences in relation to the phenomenon. This yields in-depth insights about the phenomenon.

A single case study within theoretical research is often referred as research to create new theory which later can be tested by means of quantitative research. As far as the quality criteria are concerned, it can be stated that a case study scores high on validity, but scores low on reliability. However, a single case study is extremely relevant for practical research, for example in an organization or a number of organizations. In addition, a single case study has important strengths such as novelty, testability and empirical validity, which arise from the link with empirical evidence. Given the strengths of this theory-forming approach, the quality criteria and the independence of previous literature or empirical observations in the past, it is particularly suitable for new research areas for which the existing theory seems inadequate (Eisenhardt, 1989). Therefore, this method has been chosen as the best way to investigate the process of CBMI in an ecosystem.

An inductive investigation has been chosen. This is a bottom-up method of research that is often used when little research has been done (Benders, 2017). This fits best with this explorative research and the objective of generating a descriptive model of an incomplete, documented phenomenon of the CBMI process in a business ecosystem.



4.3 The Case

For this case a circular business model innovation (CBMI) was chosen for the development of a circular building. For this research a circular building is defined as follow; '*A building that has been (re)developed and built on the basis of the principles of the circular economy*'. Nevertheless, concepts such as CBMI mainly only occur at a conceptual level in the literature and therefore selecting a case isn't an easy task. A model (table 5) has been created for this purpose, in which different cases have been compared with each other by means of established criteria. These criteria have been drawn up on the basis of the literature research in chapters 2 and 3. The following criteria have been drawn up for the case selection:

- The first criterion is that it has to be a circular building. A circular building is a building that has been (re) developed and built on the basis of the principles of the circular economy.
- The second criterion is the implementation of a CBMI. It is important here, among other things, that the various parties together have been able to implement this CBMI. A detailed explanation of the CBMI is provided in section 3.3.2.
- The third criterion is the collaboration through a business ecosystem; the collaboration was realized through collaboration with all kinds of experts, which according to Lansiti & Levien (2004) are organizations that are most intertwined. The business ecosystem consists not only of the traditional building column, but also of stakeholders of other industries.
- There is a symbiosis, platform & co-evolution; the selected case meets the three most important characteristics of a business ecosystem (section 3.4.2): symbiosis, platform and co-evolution.
 - *Symbiosis:* the companies involved in the CBMI have a loose network of organizations involved in the development and realization of a circular project. So, symbiosis indicates partners of a loose network with synergic and systematic cooperation.
 - *Platform:* through a platform, participants of the business ecosystem can provide additions through products or services. For example, market research (service) can be shared via this platform, which can be used as a supplement to the realization of circular buildings.
 - *Co-evolution:* the different participants in the case have added value together by supplying complementary assets to the core product of a circular construction.

Four cases were selected that seemed interesting for the case study of this research. A literature study has been conducted into these cases, after which they are tested against the established criteria. It concerns the following cases;

- Case 1 Renovation Town Hall Tower Municipality Eindhoven: The 'Town Hall Tower' is the first municipal building that is being renovated and preserved by a consortium of companies under the name IMPULS. In addition to the renovation of this building, they also remain responsible for maintenance for 15 years. In this sustainability project, 95 percent of all materials used in the town hall tower were reused during the renovation. For example, the old doors from the building were used in walls and old ceiling panels used as insulation on the inside of the walls.



Figure 10 - Municipality of Eindhoven



- Case 2 Head office Alliander 'Duiven': The head office of Alliander has been completely renovated. The entire renovation was largely circular. 95% of the materials in the existing building have been reused. The building no longer uses natural gas. The building is heated and cooled by heat and cold storage in the earth. In addition, the building also uses the energy of solar panels.



Figure 11 - Head office Alliander

- Case 3 Circular Pavilion ABN AMRO (Circl): The circular pavilion of ABN AMRO was completed in 2017. It is an example for the circular buildings of the future. Various circular applications can be found in the pavilion. Many of the materials used have been given a second life in the pavilion. The wooden floor consists of waste wood from bar stools, but also from old cloister floors. The window frames of the meeting rooms come from an old Philips office and the insulation is made from old jeans. In addition, the building uses as much energy as possible directly from the solar panels on the roof.



Figure 12 - Circl, Amsterdam

- Case 4 Municipality Brummen: Thomas Rau, in collaboration with construction company BAM and platform Turntoo, has come up with a concept for a circular building and built it: a city hall as a raw materials depot that can be disassembled after the usage period. The valuable raw materials and building elements are taken back by their suppliers and manufacturers after use. Ultimately, more than 90% of the design was delivered demountable.



Figure 13 - Municipality Brummen

As mentioned earlier, these cases have been tested against the criteria. By means of a ranking of +, ++, +++ the researcher judged whether the case meets the specific criteria. The ranking is divided into three levels, with + being the lowest score and +++ being the highest. + means that the case scores low on the specific criteria and +++ means that the case scores high on the criteria. ++ means that the case scores on average on the specific criteria. The scores were determined by the researcher on the basis of collected data. This data was obtained by a literature review using documents from websites of clients, architects, and contractors of the relevant cases. Also, articles from magazines and newspapers were used to obtain data. The results are shown in table 6. Appendix A explains all the scores the cases received for certain criteria, including the sources. Ultimately, for this research the case was chosen that meets the most criteria.



Table 6 - Model with criteria to select a case (+/ ++ / +++) (own illustration, 2018)

	Case 1 Renovation Town Hall Tower Municipality Eindhoven	Case 2 office Alliander 'Duiven'	Case 3: Circular Pavilion ABN AMRO (Circl)	Case 4 Municipality Brummen
Criteria				
Circular building	+	++	+++	++
Implemented CBMI together	+	+	++	++
Collaboration through a business ecosystem	+	+	++	+
There is a Symbiosis, platform & co- evolution	++	+	++	+

4.3.1 Circular Pavilion ABN AMRO

For this research, the ABN AMRO pavilion (Circl) has been selected for the case study because different parties collaborated to designed a concept of a circular building in a partnership, have actually built this despite the fact that the construction sector is still building according to the traditional linear approach and therefore Circl meets most of the criteria as shown in table 5. In addition, ABN AMRO consciously chose to go through a learning process in all openness and vulnerability and try to show, as a fairly traditional organization, a circularity that is feasible and affordable for every organisation. This is not only valuable for the bank, but also for other organizations which have little experience with circularity. The criteria will be explained below for Circl. As previously mentioned, for the other cases, the scores of the criteria are explained in appendix A.

Circular building

Circl is regarded as 'the' example for the circular building of the future. It is built according to the principles of the circular economy and therefore one of the few practical examples of circular buildings. The new pavilion is demountable, which means that the building materials can simply be used elsewhere after a possible demolition. In addition, many parts used in the Circl are re-used products/materials (ABN AMRO, 2017). However, it can be said that the pavilion a new construction is and that ensures that there is more freedom to build circularly compared to renovation. When renovating buildings, people are more likely to stick to certain frameworks and there is less freedom to build circularly. On the other hand, renovating a building makes it easier to reuse materials that come from the existing building. In the case of new construction, it is necessary to look for other ways to build circularly. Looking for these other ways will lead to new collaborations to promote the transition to a circular construction sector.

Circular business model innovation

ABN AMRO wanted to expand the head office with a pavilion to create in the first place additional meeting rooms. The project team of the ABN AMRO, which had to suffer this project, had ambitions to build circularly because of the opportunities for a bank such as ABN AMRO to have a sustainable impact with this pavilion. How they had to translate these ambitions into practice was a big challenge, but an important goal was that the design had to be made, using as much as possible according to circular principles. In addition, the project team decided that they would only involve parties who had the same ambition as ABN AMRO; building from the circular ideas. In the context of this research, ABN AMRO is the lead company in the business ecosystem.



Architekten Cie developed a plan for a circular pavilion for ABN AMRO. They described in this plan what circularity could mean for the construction industry but also for the bank. As a real estate financier, they can show what it means to build circularly, but also gain experience with lease constructions instead of ownership, financing and ownership issues. After multiple plans had already been rejected, this plan was approved by ABN AMRO and a new design was made with circular principles as the starting point. This meant that the traditional architectural sequence was reversed: instead of designing and after that looking for suitable materials, but first: which materials are available, have a low CO2 impact when it comes to production and transport, and how are they as circular as possible in to put? An example of this is that the availability of window frames in donor buildings was first examined with various parties, after which a design for the pavilion was made on the basis of this availability. The turning of this architectural sequence was necessary because of one of the most important circular points of the project team: the new pavilion must be disassembled as much as possible so that building materials can simply be used elsewhere after a possible demolition (ABN AMRO, 2017)

Business ecosystem

The development of the circular pavilion came about in collaboration with all kinds of parties, such as an architect, developer, consultant, contractor, suppliers, installers, university, who form the business ecosystem, which according to Lansiti & Levien (2004) and Zott et al (2011) are organizations with which people are most interwoven and are the dependencies that are most crucial. For this case, the companies were systematically selected that played a role in the circular business model innovation. According to Li (2009), the three most important characteristics of a business ecosystem are (1) symbiosis, (2) platform and (3) co-evolution. With the available information and documents of the case, we look at these characteristics. The first characteristic symbiosis: partners of a loose network involved in the circular business model innovation with synergic and systematic cooperation for the realization of the circular pavilion. The second characteristic platform: Cirl can be seen as a platform where circular ideas can be developed, and where companies and social organizations can come together to go further with circularity (ABN AMRO, 2017). Whether a platform was used during the process to promote the circular construction of the pavilion is not clear. This can be determined through the interviews. The third characteristic is co-evolution: the different participants of this case together added value by supplying complementary assets to the core product of a circular pavilion (Moore, 1993).

4.4 Data collection

The data is collected by several sources. The most important source is the use of interviews. The data in the current study have been collected by interviewing all involved in the business ecosystem. This is one of the three methods as described in section 4.2.1. The interviews are unstructured and therefore a topic list with topics is used instead of questions.

Topic list:

- Role of the person interviewed with regard to the CBMI in the business ecosystem (opening)
- Interviewer sends interview to four main aspects of the circular business process;
 - The evolution in time of the initiation and implementation process of CBMI
 - How is it implemented, what steps have been taken.
 - How did the collaboration go?
 - What were the obstacles and success factors



These open questions are meant to find out how the process of initiation and implementation of the CBMI has expired. Through the interviews, an attempt was made to discover why certain factors influence the success of CBMI. In addition, project documentation and articles derived from the internet, are used to outline the context of the project. These documents are used to supplement the empirical data from the interviews. This is intended to prevent research bias.

Finally, the objections to the validity of a single case study have been weighed against the possibility of gaining insight into a still incompletely documented phenomenon of the CBMI process in an ecosystem.

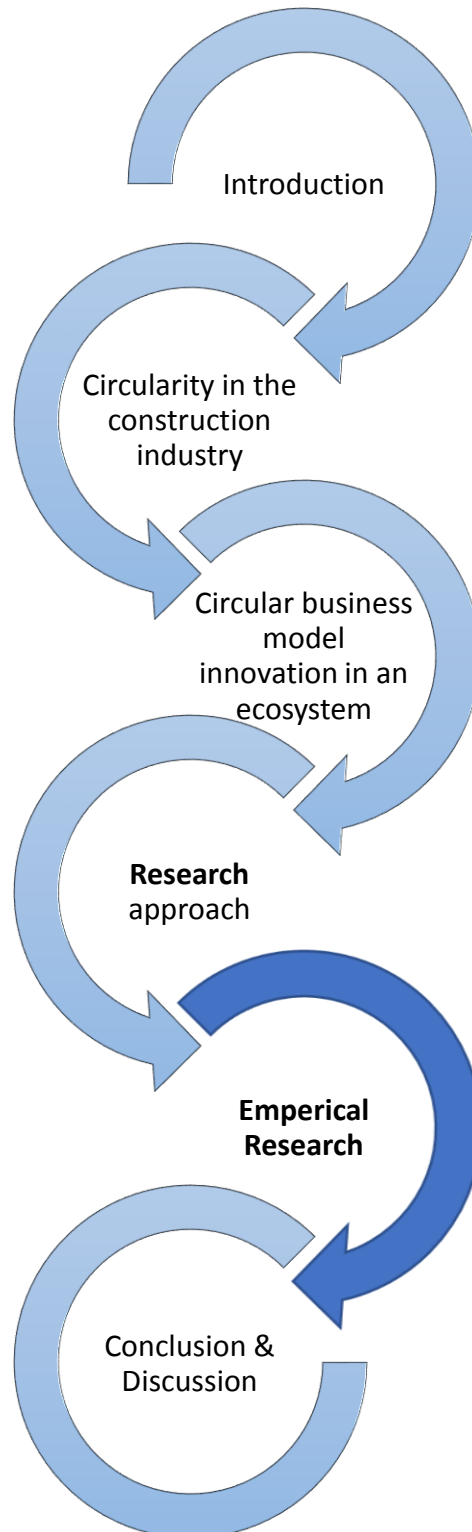
4.5 Data analysis

The different interviewees were related to the CIRCL case. All the interviewees that are included are visible in table 6. All interviews have been recorded, after which the recording has been listened to and completely written out.

table 7 - Overview interviewees (own illustration, 2018)

#	Organization	Role
1	Architekten Cie	Architect
2	ABN AMRO	Project manager
3	New Horizon	Director
4	Mitsubishi Elevator Europe	Sales Manager
5	Bureau Traject	Project manager

The analysis process is divided into different phases. In the first phase, the transcripts were drawn up by working out the interviews after which they were fully examined. This has created awareness with regard to the different viewpoints. For each interview, a copy of the relevant sections was made. In the second phase, the relevant sections were placed in a spreadsheet. After that, the relevant sections are categorized and clustered in a spreadsheet under scientific concepts to which they refer.





5. Empirical Research

In this chapter, the case Circl in Amsterdam is explored. The background of the case is outlined. This consist of an introduction of the project. Next, the empirical results are presented which were derived from the data collection and analysis with substantiation and for illustration citations from the transcripts of the interviews. The findings are presented according to the structure of the phases of innovation as described in section 3.4.3, namely phase one - the idea, phase two - the development and phase three - the implementation (Garud et al., 2013). Section 5.1 describes how the process was conducted in the first phase (the idea) and also describes the configuration of the business ecosystem. Section 5.1.1 discusses how and which success factors influenced this phase. The same was done for phase two development in paragraph 5.2 and for phase three implementation in paragraph 5.3.



Figure 14 - The phases of innovation in a business ecosystem (own illustration, 2018)

5.1 Analysis phase one 'IDEA' (2013- summer 2015)

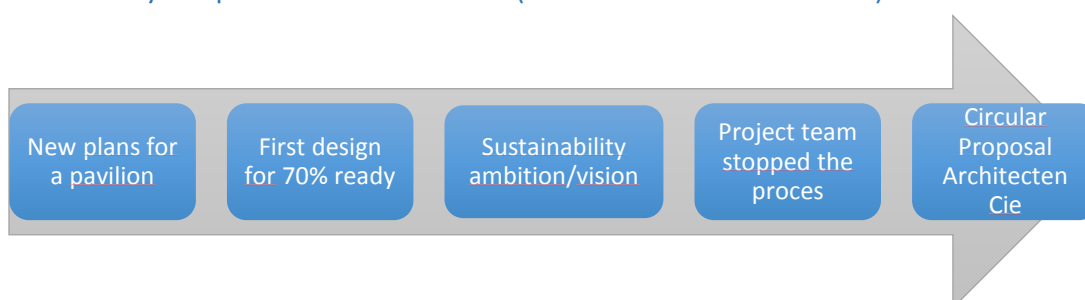


Figure 15 - Process of idea phase (own illustration, 2018)

The process of the first phase 'idea' started with the demand for a new pavilion in front of ABN AMRO's head office in Amsterdam. Plans for a pavilion have been in place since ABN AMRO set up its head office in 1999. The ABN AMRO pavilion was intended to be a meeting place for both the office population of the Amsterdam Zuid as and the neighbourhood, with catering and meeting facilities. This plan had not been implemented for practical reasons, but in 2013 ABN AMRO was asked by the Municipality of Amsterdam whether they wished to redevelop their front yard on Mahlerplein.

“In het najaar van 2013 gaf gemeente Amsterdam aan dat ze een fietsparkeergarage gingen maken op het Mahlerplein. Uit stedenbouwkundig oogpunt is toen de volgende vraag gesteld aan de ABN AMRO: “Zouden jullie willen nadenken over een mogelijke nieuwe invulling van jullie voortuin?” Vervolgens is er met Architecten Cie, die ook co-architect voor het hoofdkantoor is geweest, een studie gedaan naar een aantal scenario's om invulling te geven aan deze vraag.” (Name - Company)

In addition, a practical problem caused the plan to build a pavilion became interesting again. The head office had become too small for the number of employees and the lack of meeting space in particular became an increasing problem. In this way, the bank and Architecten Cie wanted resume the idea that there was already to build a pavilion.



At the end of 2014, the team within ABN AMRO was set up to develop and realise the pavilion. Hans Hammink, chief architect at Architekten Cie, made a beautiful design at the time: a classic oblong pavilion, with a concrete construction that fits the bank in terms of appearance. Meanwhile, Rob Kuipers, part of the project team, was also working on ensuring that ABN AMRO's head office would obtain the highest sustainability certification in the world and was not impressed by the plans. The team members were surprised that there were no sustainable ambitions while the bank saw the urgency of the climate problem and the viability of the planet. Therefore, the project team asked the builder, consultants and architect questions about sustainability, but with the current design the sustainable ambitions could not be realized. It was a difficult process in this phase because various parties in the project organisation did not want to innovate or take any risks. By now it was 2015 and the atmosphere in the project team was very tense. At that time, BAM infra had already started the construction of the concrete box that was to form the basement.

In the summer of 2015, a design meeting was then planned with the idea of encouraging the parties but this failed. On the contrary, ABN AMRO noticed that they were not in line with the parties drawing up the plans. After this meeting, ABN AMRO's project team took a radical decision and halted the process, aiming for a fully sustainable construction. They indicated that the process would only go further if there was a new proposal with which all parties wanted to commit to new, sustainable objectives. They indicated that they wanted to establish long-term partnerships with parties in order to promote sustainable initiatives.

ABN AMRO clearly indicated to those who did not want this sustainable construction will not participate in the project. After that, Architekten Cie itself took the initiative to make a proposal to the bank to build a sustainable pavilion. During that period, a student from Delft University of Technology was graduating at Architekten Cie on the subject of 'circular construction and design'. With input from the student and Delft University of Technology, architect Hans Hammink came up with a plan to build the pavilion according to the principles of the circular economy. They didn't draw a new design but they described what circularity could mean for the construction of this pavilion, as well as what circularity could mean for the bank.

“Het paviljoen kan een podium vormen voor circulaire initiatieven om de samenleving bewust te maken van de potentie.” (Name - Company)

It turned out to be a good idea, as ABN AMRO's project team became enthusiastic about the presentation of Architekten Cie. The team had a good feeling and indicated that this seems to be the proposal they were looking for. They called Hans Hammink's proposal ambitious and innovative, in which circularity was the starting point.



Configuration of the business ecosystem

At first, there seemed to be no business ecosystem. The various parties were involved because they could possibly make a contribution to the realisation of the pavilion. When the ideas for a circular pavilion were born, ABN AMRO unconsciously seems to be taking the first steps towards a business ecosystem. They indicated that they wanted to set up long-term partnerships with parties for the transition to the circular economy, but there were no concrete plans yet. The first phase involved ABN AMRO, the Municipality of Amsterdam, the architect, indirectly Delft University of Technology and BAM infrastructure.

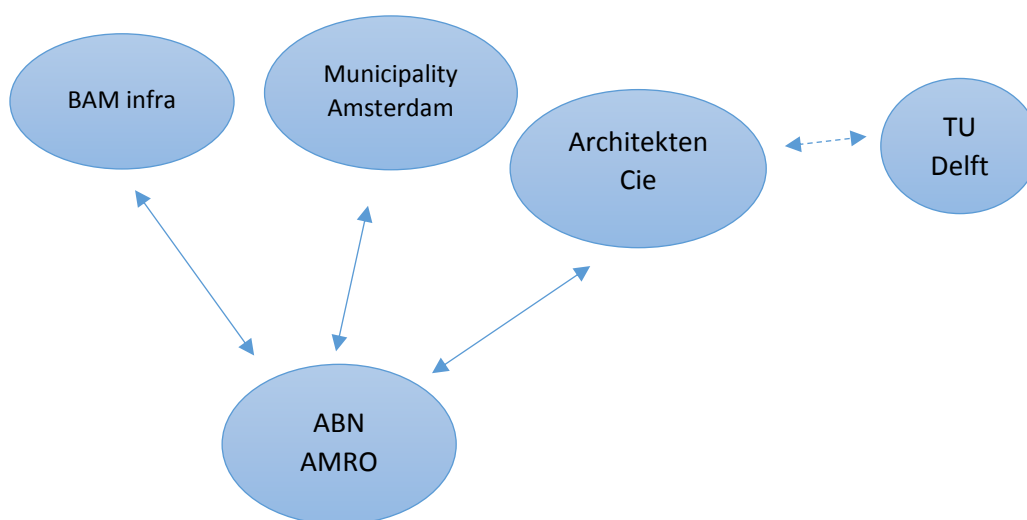


Figure 16 - Configuration of the business ecosystem in phase one 'idea' (own illustration, 2018)

Circular business model innovation

In the first phase 'the idea', the circular business model did not yet have a form. ABN AMRO had a particular ambition that was created by a social problem. During this period, Architect Cie was involved by the bank in order to give the idea more shape. A first proposal was made in which the bank's ambition was represented. This was a first step towards determining the value proposition, one of the most important elements of a circular business model (what is needed?).

5.1.1 Factors affect the idea phase

Requirement of a Lead Company

The analysis of the case study shows that the lead company is an important factor in the first phase (idea) of the innovation success. In this phase, the lead company consisted of the ABN AMRO project team. They had a clear vision and ambition to build circularly. This ensured that the bank and the parties involved had a good idea of the value they wanted to create with this idea. In this phase it was very important for the lead company to stick to the vision and ambition they had. This ensured that the process was halted by the lead company (ABN AMRO) so that the first proposal would be a good one based on their ambitions as a team.

"Het projectteam van de ABN AMRO stopte het proces en gaf aan dat ze pas verder zouden gaan als er een nieuw plan zou liggen waarbij alleen partijen mochten meewerken die zich wilden committeren aan nieuwe, duurzame doelstellingen." (Name - Company)



Trust in partner collaboration

The concept of trust in partner collaboration should be distinguished from the concept of trust. The most important difference is that while trust refers to expectations about positive motives, trust in partner collaboration refers to certainty about cooperative behaviour. Trust and control together form the trust in a partnership.

Trust

In the first phase, the interaction between ABN AMRO and the architect played an important role as the architect presented a proposal with their ideas for the new pavilion, based on ABN AMRO's sustainable ambitions. During the ideas phase, ABN AMRO knew that they needed other parties with regard to their ambitions and vision for circular construction. In addition, one of the elements to create trust in partner cooperation is the ability to adapt to each other. When it becomes apparent that ABN AMRO needs a sustainable pavilion, Architekten Cie responds by making a proposal that reflects the bank's ambitions. The quote below also shows that, at this stage, the AMRO trusted its partners by leaving responsibility to them.

“De ABN AMRO heeft nooit een bepaalde richting op gestuurd. Die verantwoordelijkheid hebben ze gelaten bij de partners. De bank heeft alleen in de gaten gehouden of het goed genoeg was en of hun ambities werden vertegenwoordigd.” (Name - Company)

Control

As described in section 3.5.1, there are three main control mechanisms, namely objectives, structure and culture. In the first phase, the objectives and structure do not yet appear to play a major role. However, in the ideas phase culture did play an important role in the success of innovation within the ecosystem. This is particularly evident in the interaction between ABN AMRO, the advisors and the architect. ABN AMRO's project team repeatedly asked these parties about their sustainable ambitions. These parties were unwilling to experiment and did not want to take any risks. Therefore, ABN AMRO concluded that they were not in line with the other parties with regard to building according to the principles of the circular economy. These differences in culture between the parties meant that the trust in good collaboration was gone. It even caused the process to be temporarily halted.

Strategic thinking

The analysis of the case study shows that strategic thinking has a high degree of influence in the first phase of the innovation process. ABN AMRO had a clear long-term vision in the ideas phase. For example, the bank's project team organised an inspirational sustainability meeting for the entire team. The importance of energy-efficient construction, the correct origin of raw materials for the future of the planet, was discussed here. In addition, the opportunities that ABN AMRO has as a major bank to discuss sustainable impact with this pavilion were also discussed. The strategic thinking of the bank's project team provided an integral approach to the importance and opportunity for circular construction. In addition, long-term orientation is an important characteristic of strategic thinking. The case study showed that ABN AMRO in particular wanted to establish long-term partnerships based on this philosophy in order to facilitate the transition to the circular economy.

Absorption capacity

At this phase, absorption capacity did not yet play a large role. However, ABN AMRO's ambition during this phase was to build sustainably, after which Architekten Cie made a proposal in which it set out its



ideas on the basis of the circular principles. They did not know exactly how they would give shape to this. The following quotation from the architect shows this.

“Dus hebben we een voorstel gemaakt waarbij we allerlei principes van circulariteit op hoofdlijnen meenamen. Hoe dit voorstel uiteindelijk vertaald zou worden naar een ontwerp was nog niet duidelijk in deze fase.” (Name - Company)

Interdependence

The idea of the project team of the ABN AMRO depends in the first place on whether their idea is also accepted on higher levels of the bank. These kinds of decisions have major consequences for a project of this size, both in terms of time and money. By these higher levels of the bank, the project team was asked to show what the thoughts / ambitions are and they will make a decision based on this. In addition, the interdependence also plays an important role in the business ecosystem because it is very important for the success of the idea of Architekten Cie to build circularly which was created by the ambition of the project team of the ABN AMRO.

Interdependence was not important in this phase because the focus here was mainly on developing an idea and creating support for it within the ABN AMRO. The idea of the ABN AMRO project team at this stage depended on whether their idea would be accepted at higher levels of the bank. Decisions of this kind have major consequences for a project of this size, both in terms of time and money. In these higher layers of the bank, the project team was asked to show what the ideas/ambitions were and on that basis the bank's top would make a decision. The interdependency may have played an internal role in this phase, but it certainly did not play a role in the business ecosystem that is the focus of this research.

5.2 Analysis phase two ‘the development’ (summer 2015 – start 2016)

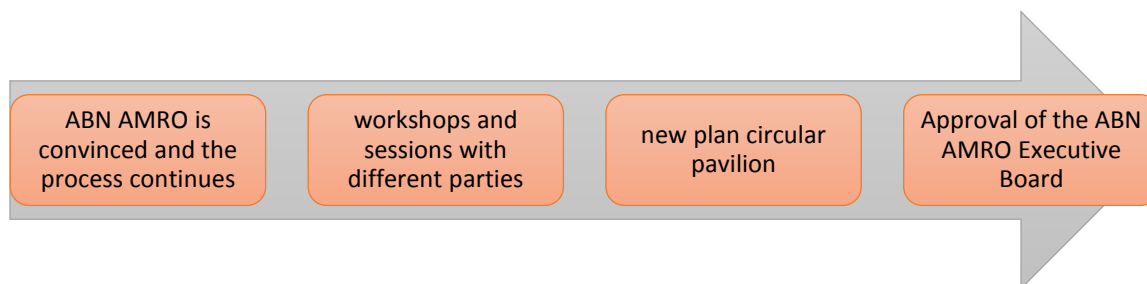


Figure 17 - Process of development phase (own illustration, 2018)

As described in the first phase, the ABN AMRO project team considered the idea of Architekten Cie to build a circular pavilion to be ambitious and innovative. In this phase, the development phase, the parties therefore decided to jointly develop this into a new design. Together with the client, architect and other advisors, a completely new design was made in three months by means of workshops and all kinds of brainstorming sessions. Whereas Delft University of Technology was indirectly involved in the first phase through Cie Architekten, they were directly involved in this phase. As mentioned earlier, workshops and brainstorming sessions were organised with the parties involved, in which decisions were taken under the supervision of the TU to flesh out the idea with the preconditions that already existed. These preconditions related to the fact that the project team, when making a new design, could no longer ignore certain choices. The reason for this was that the concrete box that was to form the foundation had already been realised, and everyone was also enthusiastic about the basic shape of the pavilion. But the changes that arose from these workshops and sessions and that ended up in



the new design by Hans Hammink (Architekten Cie) were big. Especially because of one of the most important circular points: the new pavilion must be as demountable as possible, so that the building materials can be used somewhere else after a possible demolition of the building at the end of their lifetime. This meant reversing the traditional architectural order: not first designing and after that looking for suitable materials, but: which materials are available, have a low CO2 impact when it comes to production and transport and how can they be used as circularly as possible?

In this way a lot of choices had to be made. During those workshops and sessions it became increasingly clear that many of those choices could only be made gradually during the construction process (in the implementation phase). This was because circular construction was new to many parties. The quotation below substantiates this.

“De meeste obstakels die wij ervaren tijdens het proces kwamen voort uit het feit dat wij vaak de eerste vraag stelden aan leveranciers met betrekking tot circulariteit omdat circulair bouwen nieuw was voor veel van deze partijen. Deze leveranciers gaven hierbij dan ook aan dat zij nog niet klaar waren om te leveren volgens de principes van de circulaire economie” (Name - Company)

The principles of circular economy such as the use of as few raw materials as possible and the disassembly of materials and components were clear to these parties. On the contrary, it was unclear to them how to put this into practice.

After the brainstorming sessions, ABN AMRO's project team, organised a meeting for all stakeholders. Here that the plans for the new pavilion were presented to the general public. This showed that everyone was enthusiastic, after which the project team presented the new plans to the managers at ABN AMRO who were dealing with the real estate. The project team's message, vision, ambition and idealism were contagious, which impressed ABN AMRO's top management. Another factor was that ABN AMRO is a major player with a major impact on the construction and real estate markets, where sustainability and circularity are undeniable themes that will affect the construction and real estate sectors in the coming decades. The top of the bank (executive board) therefore believed in this new direction and on this basis it was decided that the project could proceed definitively. The quotations below show that there was support for this direction from the top of the bank.

“Met name de leidinggevende van Rudolf (lid projectteam ABN AMRO) tot aan de raad van bestuur van de ABN AMRO hebben het hele team de ruimte gegeven om dit project op deze manier te doen.” (Name - Company)

Configuration of the business ecosystem

In the first phase, the first steps were taken towards a business ecosystem because ABN AMRO indicated that it wanted to establish long-term partnerships with parties in order to promote innovative initiatives with regard to circular construction. Section 3.4.2 shows that the importance of relationships, partnerships and collaboration is important in a business ecosystem. The parties involved in the first phase were ABN AMRO, the Municipality of Amsterdam, Architects Cie and TU Delft.

The business ecosystem takes form in the development phase. In this phase, the ecosystem will be expanded with a direct relationship between the ABN and the TU Delft, installation advisor and a number of other advisors with whom the workshops and sessions were held to look at the possibilities of building according to the principles of the circular economy. The project team of the ABN AMRO



was not convinced of the first installation advisor, as a result of which the BAM became the installation advisor later on in this phase. The municipality of Amsterdam remained involved in this phase as a stakeholder at a distance.

Figure 18 shows an overview of the configuration of the business ecosystem in phase two "development". The participants of the first phase are shown in blue and the participants of the second phase are shown in red.

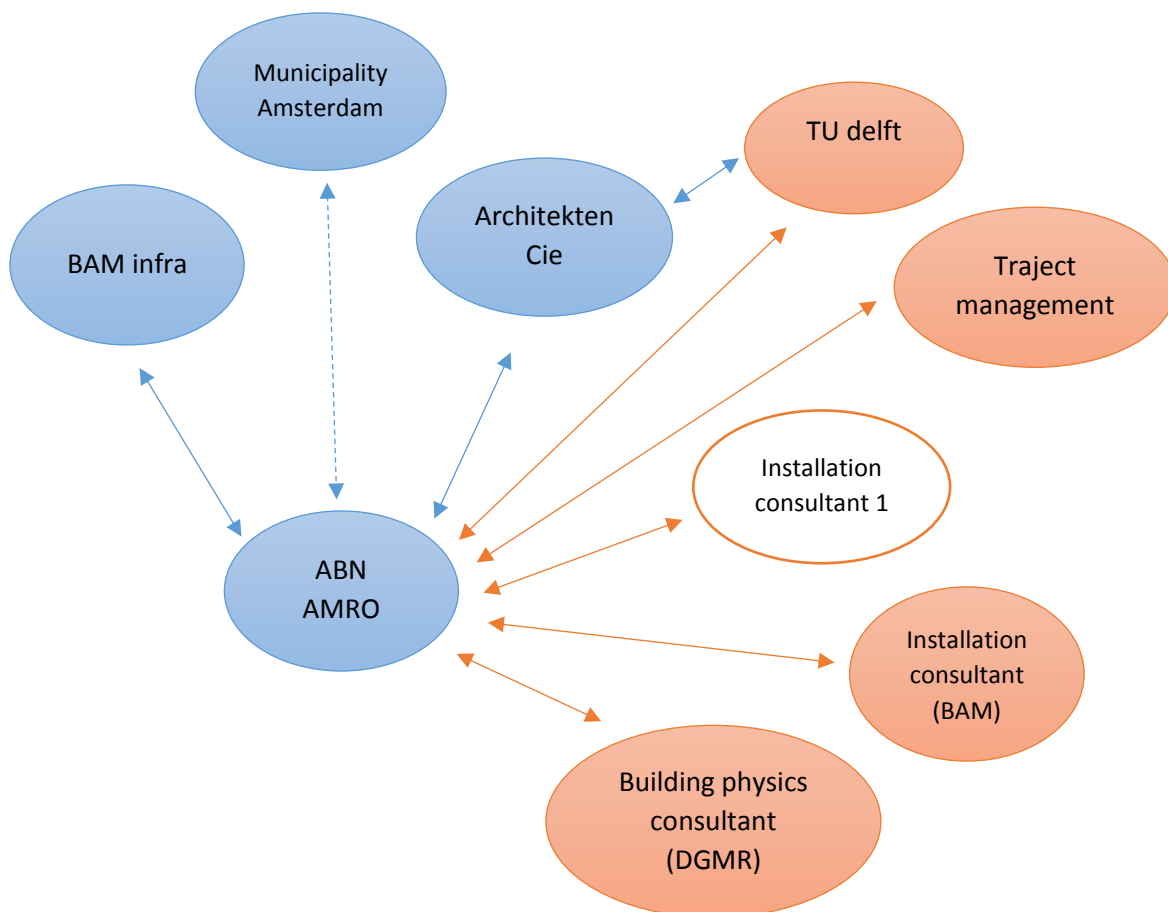


Figure 18 - Configuration business ecosystem phase two 'development (own illustration, 2018)

Circular business model innovation

In the second phase, the development phase, the circular business model (CBM) took form. One of the building blocks of a CBM (section 3.2) is the fact that the circular economy asks for this to be organised together with partners. For example, ABN AMRO organised workshops and brainstorming sessions with partners in order to take decisions on building according to the principles of the circular economy and, ultimately, a new circular design. In addition, the value that is being created is that circular real estate has been delivered where materials are no longer considered as waste. This is designed to prevent the future exhaustion of natural resources. ABN AMRO required in advance that only parties with the same ambition could participate. These parties form the key partners that form one of the nine keystones of a business model (figure 5, paragraph 3.1).



5.2.1 Factors affect development phase

Requirement of a Lead Company

In the second phase, the lead company also played an important role because ABN AMRO had to convince the other partners of this new direction and way of developing. During the development phase, new participants were added to the business ecosystem that could contribute to adding value to the circular business model. This addition of value is necessary to achieve a successful circular business model innovation. ABN AMRO was unable to deliver this value itself and therefore organised brainstorming sessions with other parties who could add value. The lead company had a coordinating role here and connected all the participants.

“Gelukkig hebben we de tijd gekregen om een nieuw idee uit te werken. Dit hebben we gedaan door workshops en brainstormsessies te organiseren. Hier zijn destijds verschillende partijen bij aangehaakt waaronder de TU Delft, Traject, en enkele adviseurs. We zijn met deze partijen rond de tafel gaan zitten en onder begeleiding van de TU hebben we toen gezegd “Hoe gaan we hier invulling aan geven met de randvoorwaarden die we al hebben? We hebben vervolgens een aantal sessies georganiseerd om een nieuw plan te bedenken waar ook het huidige ontwerp van het circulair paviljoen uit is gekomen.” (Name - Company)

Trust in partner collaboration

Trust

In the development phase, trust played an important role in the success of innovation in the ecosystem. This is evidenced by the fact that the various parties in the ecosystem continue to invest in time, money and knowledge, whereas the process had previously been halted in the first phase. The trust in the idea, the ambition and the direction taken, but especially the trust in each other, appears to have been important in this phase. Both between the parties involved and internally within ABN AMRO.

“In dit proces ging het uiteindelijk om de partijen die aan tafel zaten want die moesten het ontwikkelen en realiseren. Als bank hebben we dan ook veel vertrouwen gegeven aan deze partijen omdat we wilde dat ze de ambities van de bank begrepen en op basis daarvan met goede voorstellen zouden komen.” (Name - Company)

In addition, internal trust within ABN AMRO has been very important. ABN AMRO was the client, financier and end user. So there had to be trust from the board of directors to the project team in order for this project to actually go ahead, while this was a new concept in which no one could demonstrate in advance that it would succeed. This approval was eventually obtained because the project team was able to present the new plans convincingly to the board of directors.

“De nieuwe plannen voor het circulaire paviljoen zijn op een gegeven moment gepresenteerd aan de raad van bestuur. Als projectteam hebben we toen de twee verschillende scenario’s van een circulair paviljoen en van een traditionele paviljoen gepresenteerd. Hier hebben we tijd, kwaliteit en kosten toegelicht waarbij kwaliteit vooral in het teken stond van duurzaamheid. Hiermee hebben we ze weten te overtuigen van de voordelen van een circulair paviljoen.” (Name - Company)

Control

The case study shows that control did play a role in the development phase. Control mechanisms and the degree of control are two important concepts in this respect. Control is the direct result of the



control mechanism process as described in section 3.5.1. Companies want to use control mechanisms to promote non-routine activities, such as learning how to take risks and innovate. The quotation below shows that daring to take risks was important.

“Als je een partij hebt die niet open staat voor innovatie en bang is om risico’s te nemen dan zal zo iets nooit slagen. Je neemt een risico welke per definitie geld kost. Als partijen daar toe niet bereid zijn dan sla je het al heel snel plat en blijft er van de innovatie weinig over.” (Name - Company)

In this second phase, the participants of the business ecosystem had the challenging goal of developing a pavilion as a pioneer according to the principles of the circular economy. In addition, the process was halted in the first phase due to cultural differences between the parties involved. In this phase (development phase), culture also plays an important role in the success of innovation in the ecosystem. ABN AMRO tried to manage cultural differences during this phase by organising sessions with each other to ensure that, despite the cultural differences, the ambition would be the same, namely to build according to the principles of the circular economy.

Strategic thinking

In the first phase, ABN AMRO clearly had a social vision. This vision came later in the process, in the second phase (development), together with the ambition to build according to the principles of the circular economy. The bank's vision regarding to the depletion of raw materials, the future of the planet and the opportunities for ABN AMRO as a major bank to have a sustainable impact with this pavilion were reinforced by the plan presented by Architect Cie to build a circular pavilion. In the end, this social vision was also implemented in the design. In addition, strategic thinking was required to learn how the challenges could be translated into targeted actions that ultimately resulted in the design actually being built.

“Dus dan moet er zoveel mogelijk risico’s worden gemeden waardoor het bijna ondoenlijk is om innovaties in de bouwkolom te krijgen. De reden hiervan was dat de afstanden te groot waren tussen de betrokken partijen. Voor de ABN AMRO was het daarom een grote uitdaging om juist die afstand te overbruggen door risico’s te nemen. Het nemen van deze risico’s was een bewuste keuze van de bank zodat er ruimte gecreëerd kon worden voor de innovaties.” (Name - Company)

Absorption capacity

Absorption capacity played an important role in this phase. After ABN AMRO was convinced of Architecten Cie's new proposal, the participants of the business ecosystem worked together to develop the proposal into a real plan and new design by means of workshops and all kinds of working sessions. The different parties all had certain specific knowledge which was added to the total.

“Waar het om gaat is dat je de mogelijkheden om circulair te bouwen wilt zien en wilt gebruiken. Het is dus een andere manier van creativiteit gebruiken en een andere manier van ontwerpen.” (Name - Company)

“Als je een partij hebt die niet open staat voor innovaties en hiermee zijn mogelijke inbreng beperkt om zo risico’s te vermijden dan wordt het lastig. Het durven nemen van die risico’s is waar het uiteindelijk om gaat.” (Name - Company)



Interdependence

In the development phase (phase two), various parties such as Delft University of Technology and installation consultants were added to the business ecosystem. All parties in the ecosystem added value to the development of the pavilion in order to ensure that it could be built as circularly as possible. In that perspective, they were dependent on each other's contribution to ultimately jointly develop a circular pavilion. The various parties that participated in the circular business model innovation knew what their contribution was to the whole. They were interdependent because each contributed to the total value. Therefore, it was the enumeration of all the value that led to a whole of the concept of building according to the principles of the circular economy.

5.3 Analysis phase three 'implementation' (start 2016 - 2017)

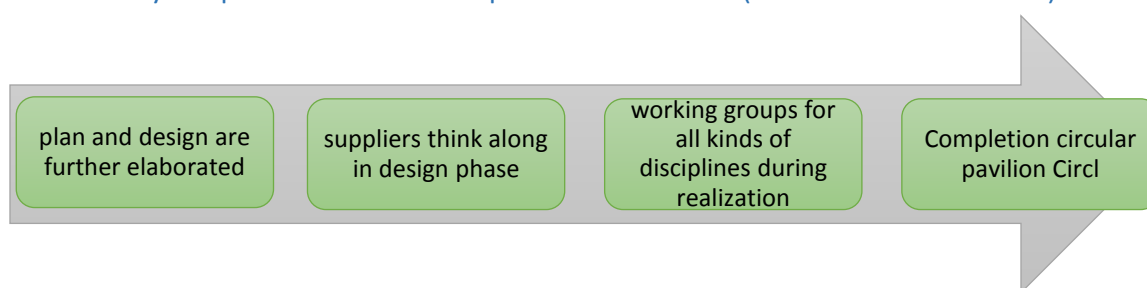


Figure 19 - Process of development phase (own illustration, 2018)

In phase two (section 5.2), the members of the Managing Board of ABN AMRO gave their approval, so that the project team was finally allowed to proceed. The members saw the opportunities offered by the new direction of the project team and so the circular pavilion could be built. This is where phase three - the implementation - began. The board of directors indicated that the project team had to ensure that the project would be feasible in practice and that it should fall within the scope of the planning. There had to be a right balance between time, money, functionality and circularity because if the bank is going to do this, the lessons had to be feasible and affordable for others as well.

After the top of the bank had agreed, things went very hard. The project team knew that things really had to change. Hans Hammink's design and plan was further developed, after which BAM also became more involved as a contractor. As for many parties, it took some time to get used to the BAM. The new design meant that the contract with BAM infra BV had to be renegotiated because, of the entire concrete structure in the first design, only the cellar basement would remain in the new design. In addition, an agreement had to be concluded with BAM Construction & Technology for the further construction, completion and installation in which the bank wished to remain more directly involved than usual. As a result, BAM was contracted as the main contractor by means of the UAV-gc contract. This is an integrated contract in which BAM also had a design responsibility. In the further elaboration, Architekten Cie acted more as a kind of assessor of the quality and of the image quality than as an actual designer.

In addition, ABN AMRO took a well-considered decision to involve potential partners - from supplier to installer - early in the design process in the implementation phase, in order to make better use of market knowledge and challenge them to think further. To this end, ABN AMRO, in consultation with the contractor, architect and advisor, selected the party that had really thought about the circular principles and wanted to put them into practice. This sometimes resulted in unusual situations. When BAM negotiated with these suppliers, members of the ABN AMRO project team were regularly present. The client at the same table with the contractor when talking to suppliers is not really common. But it



fits with the circular principles, in which you work together to find the best circular solutions. The quotation below also shows the importance of selecting these suppliers as early as possible.

“Al heel snel werd onderkend dat het vroeg selecteren van leveranciers belangrijk was zodat zij met de kennis die zij hadden vroegtijdig inbreng konden leveren aan het project. In principe is het zo dat de aannemer dit soort taken op zich neemt maar bij dit project was het de ABN AMRO die dat zelf is blijven doen in samenwerking met de architect, adviseurs en de BAM. Dat heb ik als architect niet vaak meegemaakt.” (Name - Company)

In the development phase (section 5.2) it became clear that many choices had to be made during the implementation phase. This was because circular construction was also new for many suppliers. The process was also different from that traditionally carried out by the parties. A big difference was that all different working groups were made for all kinds of disciplines around the design. There was a working group that only dealt with the main structure, working groups for the facade, roof and installation, but also a working group for the market consultation. In traditional building processes there is generally one design team and in this project the design team was the meeting of all those workgroups. One of the working groups was therefore the market consultation, in which ABN AMRO, together with the consultants, architect and BAM, selected all the suppliers with whom the project was ultimately realised. After this selection, there was still the main contractor who was responsible for the coordination of the different suppliers during the construction.

Configuration of business ecosystem

In the second phase, the business ecosystem consisted of ABN AMRO, the Municipality of Amsterdam, Architecten Cie, TU delft, BAM infra, Traject, installation consultant 1 and later BAM as installation consultant and DGMR. In the third phase - the implementation - the configuration has been expanded with companies involved in the realization of the circular pavilion. In this case, the project was transferred from BAM infrastructure to BAM Construction & Technology. In this phase, it also involves suppliers, installers and other subcontractors. In addition, working groups have been set up, including suppliers and subcontractors for each discipline. Working group 1: Main structure, working group 2: Façade, working group 3: roof and working group 4: installations, working group 5: market consultation.

Figure 20 shows an overview of the configuration of the business ecosystem in phase three 'implementation'. The participants of the first phase are shown in blue, the second phase is shown in red and the third phase in green. In addition, it is shown in black how the design team proceeded through working groups in the realization phase.

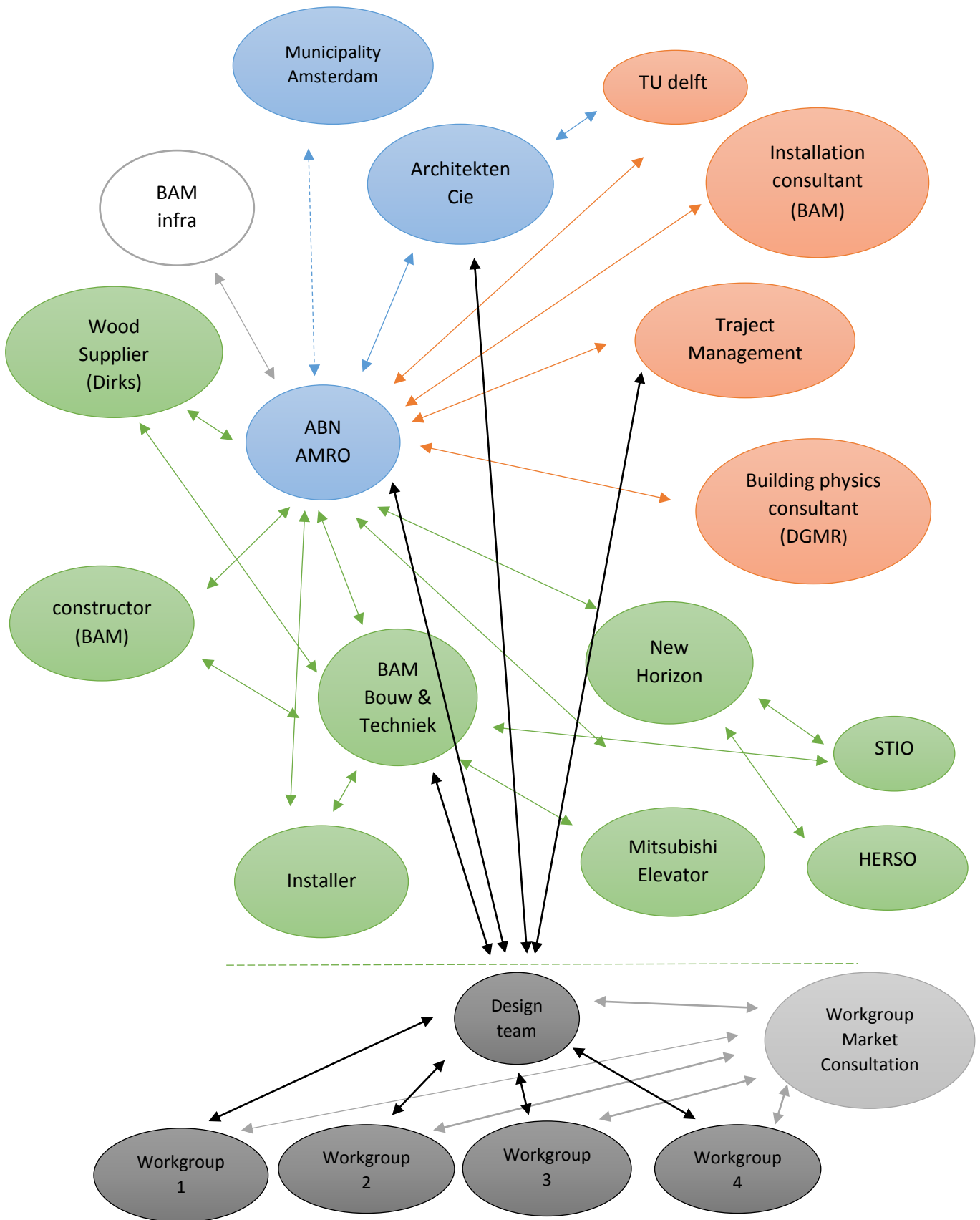


Figure 20 - Configuration of business ecosystem in phase three 'implementation' (own illustration, 2018)



ABN AMRO's ambition in advance was to enter into long-term partnerships with parties in order to facilitate the transition to the circular economy. The circular pavilion was to be a first step in this direction, after which more circular real estate would have to be realised and perhaps new markets could be created as a result. This can be placed in the context of a business ecosystem in which different parties work together to be innovative and in which social problems are also tackled by means of co-evolution. However, it has emerged that in the implementation phase the business ecosystem falls apart after the first project has been realised in accordance with the principles of the circular economy. The interviews revealed that the project ultimately turned out to be a commitment between people rather than between parties, which was one of the reasons why the ecosystem fell apart too easily after construction of the circular pavilion.

Circular business model innovation

In the implementation phase, the circular business model (CBM) was further developed. The building block of a CBM to organise this together with partners was further improved in this phase. More parties added a specific knowledge/service and thus added value. Suppliers and contractors were involved in the process much earlier so that they could think about the design with their specific knowledge of certain disciplines. To this end, the working groups for each discipline were set up to report to the design team. In addition, an important building block of a CBM is the closing of a material cycle that is possible with parties from the business ecosystem. As mentioned earlier, this meant that the traditional architectural order was reversed: not first designing and then looking for suitable materials, but: what materials are available, have a low CO2 impact in terms of production and transport, and how can they be used in as circular a way as possible? For example, a party such as New Horizon took materials from so-called 'donor buildings' that were eventually used in the circular pavilion.

An important keystone of a business model is the revenue stream. The case study showed that this project was seen by many parties as an experiment. An experiment from which a lot of lessons could be learned and from which a lot of new insights were gained but in which the process cannot be applied directly to other projects because building according to the principles of the circular economy resulted in a negative revenue stream which is an important keystone of a business model. The circular pavilion appears to have been a major financial investment in which the predetermined goal, that it must also be achievable for others, was not achieved. The priority to build circularly weighed more heavily than the costs, so often not the cheapest choices were made, but the choices that scored high on circularity.

5.3.1 Factors affect implementation phase

Requirement of a Lead Company

In the implementation phase, the role of the lead company was very important. They had to connect the different parties from the ecosystem who had to jointly develop the innovation. In addition, the case study showed that the lead company really had to be strong during this phase in order not to fall back into traditional building and so they had to continue to steer on the ambition they had. The quotations below substantiate this.

“De ABN AMRO heeft gestuurd op de ambitie die ze hadden. Ze hebben ervoor gezorgd dat iedereen gelijkwaardig met elkaar communiceerde, respect had voor de ander en enthousiast was over de innovaties en circulariteit. Ze hebben dan ook bewust gestuurd op deze aspecten welke belangrijk zijn om de samenwerking te laten slagen.” (Name - Company)



“Initieel is het zo dat de opdrachtgever (ABN AMRO) dit wel moet ondersteunen. Je moet als opdrachtgever wel echt een rechte rug houden als je dit soort innovaties wilt doorzetten.” (Name - Company)

Another role of the lead company is to stimulate incentives to deliver total value and thereby promote knowledge sharing. In the implementation phase, for example, the lead company (ABN AMRO) made a conscious decision to involve the supplier early on in the process in order to be involved in the thinking and design process. In this way, they ensured that the knowledge of the suppliers was used optimally with regard to innovative initiatives for the pavilion and, in addition, they jointly build up knowledge. The quotation below shows why it was important to involve these suppliers at an early stage.

“Als opdrachtgever zijnde is het belangrijk geweest om al die partijen in een vroeg stadium mee te laten denken over wat vandaag de dag de beste oplossing is voor het project. Wat hiermee voorkomen word is dat leveranciers niet achteraf aangeven dat ze innovatieve ideeën hebben die veel beter toe te passen zijn op het project. Men wilt hiermee juist de kennis van de markt vroegtijdig gebruiken en vooraf weten wat het beste past. Dat is dus ook de reden dat de lijnen tussen opdrachtgever en leverancier vaak direct liepen.” (Name - Company)

The implementation phase consists not only of the construction of the circular pavilion but also, and above all, of stimulating and maintaining the business ecosystem in order to promote the transition to the circular economy. The lead company has an important role to play in this. As the lead company, ABN AMRO ultimately failed to do this. After the realisation of the circular pavilion, the business ecosystem collapsed.

Trust in partner collaboration

Trust

During the realisation of the pavilion in the implementation phase, trust played an important role. This is evidenced by the fact that the implementation of innovative ideas was an interplay between the various parties. ABN AMRO has also emphasised this, particularly in the implementation phase, by not steering in a particular direction but offering the opportunity for input from other parties. This is supported by the following statement.

“Ik denk dat het daarbij belangrijk was dat de opdrachtgever de ruimte gaf voor de inbreng van de adviseurs. De opdrachtgever stelde een heel ambitieus doel maar gaf vervolgens alle ruimte aan adviseurs om dat zo goed mogelijk in te vullen. Daarnaast was het ook noodzakelijk om open te staan voor de inbreng van een ander.” (Name - Company)

In addition, mutual trust, the award of contracts to each other and investment before the return is achieved, plays an important role in the cooperation of the participants of the business ecosystem. This is important because if there is no trust and the parties want to see a return first, this will not benefit the collaboration and the innovation. Therefore, mutual trust is very important.

“Uiteindelijk hebben we met elkaar ingestemd op basis van het feit dat een dergelijk project gewoon gerealiseerd moest worden. Dit is uiteindelijk ook gebeurd waar de investering voornamelijk in marketing heel wat waarde heeft opgeleverd.” (Name - Company)



Yet, especially at this stage, it turns out that trust was not what it had to be, which ultimately jeopardised the innovation process. This is substantiated by the quotation below.

“De ABN AMRO viel terug in zijn traditioneel rol als opdrachtgever in plaats van vertrouwen in samenwerking en co-creatie doordat ze bang waren dat er te veel geld betaald moest worden bij het inkopen van het contract van BAM. Hierbij speelde mee dat de bank minder goede ervaring had uit een eerder project met de BAM. Dat heeft er uiteindelijk toe geleid dat het veel tijd kostte om weer een vertrouwensband op te bouwen waarbij men vanuit co-creatie wilde gaan werken.” (Name - Company)

Control

Culture played an important role in the implementation phase. This is evident from the fact that the various participants involved in the realization of the pavilion had to get used to the new approach in which the construction process was reversed and in which it was first examined with suppliers which materials were available and how these could be used in as circular a way as possible.

“Het was vooral moeilijk om de leveranciers te overtuigen van deze manier van werken. Zij waren niet gewend om inbreng te mogen geven waardoor enkele leveranciers in het begin een beetje wantrouwend en kritisch waren. Uiteindelijk konden we ze wel overtuigen waardoor ze meededen aan het project.” (Name - Company)

In addition, they tried to control cultural differences on the one hand by working with regular partners aimed at long-term cooperation and by concluding agreements to jointly build up knowledge towards the transition to the circular economy. In addition, solutions were sought jointly if a problem occurred in order to organise the process as well as possible in this way. Sustainable thinking, with a social vision and implementation in accordance with the principles of the circular economy, is a major cultural change in the traditional construction chain, among suppliers, installers and also among contractors. This sometimes caused the necessary friction, as shown in the quotations below.

*“Ik was in gesprek met de * over wat ik mogelijk kon leveren maar we kwamen er gewoon niet uit. De * was naar mijn mening erg moeilijk, waarbij ze aan de ene kant graag spullen wilden afnemen maar waar ze aan de andere kant gewoon niet concreet genoeg waren. Zij verschuilde zich dan steeds achter de opdrachtgever en ik was dus blij dat ik vanaf een bepaald moment direct met de opdrachtgever rond de tafel zat.” (Name - Company)*

“Ik heb een paar keer in een presentatie het voorbeeld genoemd van een spreekwoord in de wereld van projecten doen. Dat spreekwoord luidt: 'zonder wrijving geen glans' Je moet een beetje wrijving hebben om tot en mooi project te komen. Nou dit project kon ik zonder zonnebril niet meer naar toe. Hier zat zoveel wrijving op, dat was gewoon vechten.” (Name - Company)

In the first two phases, the need for objectives and structure was less. In the third phase, there was a need for a structured process and for agreements to be recorded in order to exercise more control. Before the realisation of the pavilion, control therefore ensured that the parties had more confidence in the collaboration. But at the same time it was not possible to make agreements with regard to the business ecosystem to see how the parties could remain connected for the future. So it turned out that trust in partner cooperation was not good enough in this phase.



“Dit betekende dat het voor de ABN AMRO en voor mij ook best intensief is geweest want normaal hou je je niet zo bezig met de selectie van de leveranciers want dat doet de aannemer. Bij dit project hebben wij ons daar heel erg mee bemoeid en dus ook meegeschreven aan de documenten die we naar de leveranciers stuurde. Normaliter ligt dit allemaal bij een aannemer dus dat heeft best wel veel tijd en energie gekost maar uiteindelijk hoop je natuurlijk dat je dat terugwint door daarna een wat soepeler proces te hebben omdat je weet dat je de juiste partijen hebt gekozen.” (Name - Company)

Strategic thinking

The strategy/vision that was developed in the first phase was a guideline for the actions that were taken during the implementation phase. This is evidenced by the fact that when parties tended to fall back into the traditional way of building, for example because of the risks or costs, the lead company stuck to the vision. This was important in the implementation phase so that the goal and ambition to build according to the circular principles can be achieved. Strategy and vision play a different role in the implementation phase than in the other two phases. In the earlier phases it served more to gain support for the idea within the business ecosystem. In the implementation phase, the vision served more as a guideline, on which everyone could rely in case of decisions and/or problems. The case study showed that, in this phase, this only applied during the realization because long-term orientation had disappeared, which is an important characteristic of strategic thinking. This was because the parties could not make any firm agreements with regard to take-back guarantees, etc. This is shown by the quotation below.

“De onbekendheid en de risico's die men nog ziet in deze ontwikkelingen zorgde ervoor dat we geen harde afspraken konden maken met betrekking tot terugname van materialen en producten. We hebben met heel veel partijen gesprekken gevoerd hierover om dit contractueel af te spreken. In de praktijk bleek dit erg moeilijk te zijn waardoor we hier niet in geslaagd zijn.” (Name - Company)

Absorption capacity

In the implementation phase it had been important that different ideas were adopted on time because the construction had already started, the concrete box was already realized so the design had to run ahead of the construction so that the process did not come to a halt. As a consequence, there was not really time to allow innovations to emerge, but the team eventually succeeded in realising a circular pavilion. The quotations below substantiate this.

“Tijdsdruk gaat soms ten koste van de kwaliteit omdat er geen tijd was om een echte innovatie van een product te laten ontstaan. Daar is vaak onderzoek en verschillende testen voor nodig welke tijd kosten. Deze tijd was er niet bij dit project dus waren we altijd wel beperkt in producten die hun diensten al bewezen hadden of waarin we veel risico's namen. Dus in die zin, is dat natuurlijk een enorm nadeel geweest.” (Name - Company)

“Wat je vaak ziet is dat bij circulariteit of bij duurzaam bouwen, mensen al snel spreken over dat je gebouwen moet maken met een adaptief vermogen. Je moet dus toekomstige functionaliteiten kunnen veranderen en toekomstige technieken omarmen. Bij dit project is vooral het proces adaptief geweest dus het team is in staat gebleken om nieuwe wendingen en nieuwe ontwikkelingen te omarmen.” (Name - Company)



Interdependence

In the implementation phase, the various roles in relation to each other were given more form, in the business ecosystem. This was mainly during the realization of the pavilion. This is evident from the fact that BAM was contracted as the main contractor by means of the UAV-gc contract, which made it clear what roles the parties were assigned in relation to each other. The quotation below justifies this.

“Daar is uiteindelijk het gebouw zoals het er nu staat ontworpen. De BAM is als hoofdaannemer gecontracteerd door middel van het UAV-gc contract. Dat betekende dat het een geïntegreerde contract was waarbij ze ook de ontwerpverantwoordelijkheid hadden. Architecten Cie had hierdoor in de verdere uitwerking meer de rol van toetser van de kwaliteit en van het beeldkwaliteit in plaats van de ontwerpende rol. De BAM heeft met name het ontwerp uitgewerkt naar een DO en uiteindelijk tot een uitvoeringsontwerp.” (Name - Company)

In the realization all services/products together formed the whole. They were dependent on each other whether the product/service was delivered correctly and on time. In the implementation phase, the process was adapted to this and was put into a different light than the way in which the traditional staff is done. The quotations below explain how the process was initiated.

“We hebben het proces wel iets anders gedaan dan we traditioneel gezien gewend zijn. Een groot verschil was dat we verschillende werkgroepen hadden gemaakt waarbij we voor allerlei disciplines rondom het ontwerp maar ook alles daaromheen werkgroepen hadden. We hadden een werkgroep die zich alleen bezighield met installatietechniek, een werkgroep die zich bezighield met de gevel, een werkgroep met het dak, met de hoofdconstructie maar ook een werkgroep met marktconsultatie. Normaal gesproken heb je één ontwerpteam waaruit je alles doet en hier was het ontwerpteam het samenkomen van al die werkgroepjes. Dus we hadden het ontwerpteam en daarin zaten enkele personen welke weer allemaal in verschillende werkgroepen zaten die een bepaald onderdeel van het project oppakten. Eén van die werkgroepen was de marktconsultatie waarin we samen met BAM alle onderaannemers geselecteerd hebben. Deze manier van werken was toch wel uniek.” (Name - Company)

“De werkgroep waren de experts voor hun specifieke discipline dus lieten we hun de verschillende opties tegen elkaar afwegen waarbij ze naar circulariteit, kosten, levenscyclus kosten en esthetiek moesten kijken. Wat wij van jullie willen is gewoon een afgewogen voorstel waar wij als ontwerpteam alleen nog maar ja of nee op hoeven te zeggen. In elk werkgroep zat er iemand die ook weer in het ontwerpteam zat om de integraliteit te waarborgen.” (Name - Company)

Finally, it was established during the case study that the parties were interdependent only during the realization of the pavilion and no longer afterwards. An important success factor for innovation in a business ecosystem is its interdependence, and if there is no such interdependence between parties, the business ecosystem is likely not to continue to exist. In this case, this was an important reason why the business ecosystem collapsed. In addition, the case study has shown that, in a sector such as construction, it is simply very difficult to get the parties to agree to be interdependent.



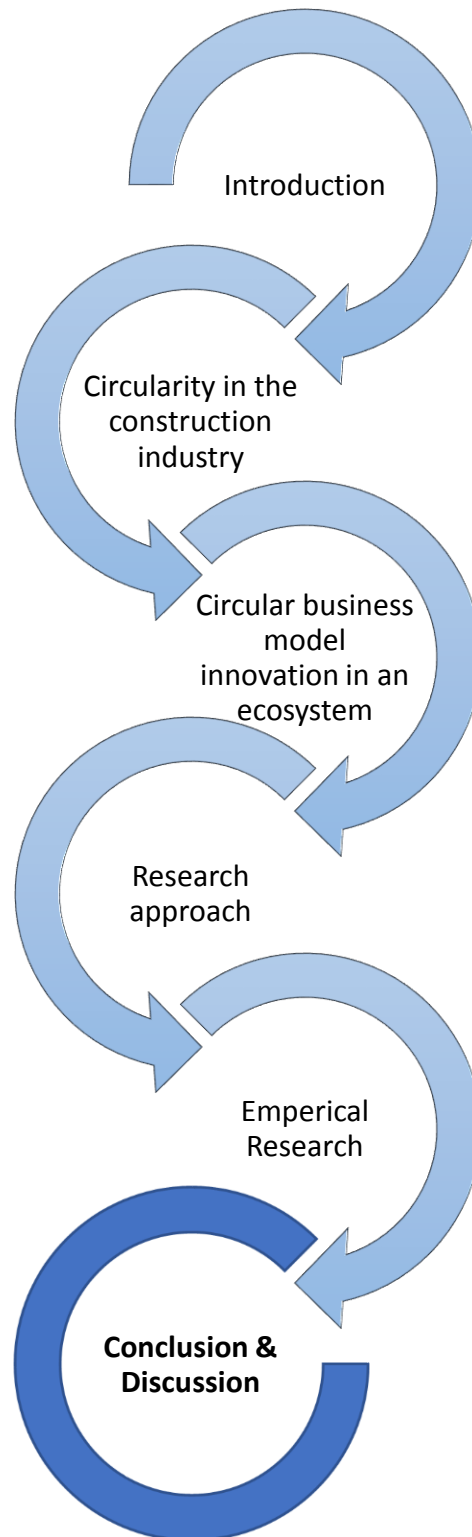
5.4 Conclusion empirical research

By means of the case study, a lot of insight was gained into how the process for the realization of the circular pavilion went and which factors were influential. The process is divided into three phases (idea, development and implementation) of innovation in a business ecosystem, as described in section 3.4.3. During the first two phases of the idea and development, the circular business model innovation (CBMI) seemed to take on more and more form in a business ecosystem, but this changed in the third phase (the implementation phase) where the project was actually realized. As lead company, ABN AMRO's aim in the past was to build long-term partnerships with parties in accordance with the principles of the circular economy, but especially in the final phase it was the absence of various success factors that caused the business ecosystem to fall apart. Table 8 gives an overview of the success factors of a CBMI in a business ecosystem and whether these have had a positive (+), negative (-) or no influence (0) on the success of a circular business model innovation in this case.

In the idea phase, at a certain point in the process, there appears to be no trust anymore in a partner cooperation, as a result of which the process was even temporarily halted. Table 8 shows that the factor 'trust in partner cooperation' therefore had a negative impact on innovation in the business ecosystem in the first phase. Also, it seems that absorption capacity and interdependence do not play a role in this phase. The literature (section 3.5.1) supports the view that interdependence does not yet play a role in the success of innovation at this stage. In the development phase, all factors have a positive influence on the success of the circular business model innovation in the business ecosystem and the ecosystem seems to be taking more form. The process continued and there was renewed confidence in partner cooperation. In addition, the other factors had a positive influence on the success of innovation in the business ecosystem. In the implementation phase, the circular pavilion was built. Table 8 clearly shows the absence of the success factors (all - characters) in the implementation phase. This is explained in detail in paragraph 5.3.1. As a result, the business ecosystem ultimately collapsed once the project had been completed. For example, there was no longer any trust in partner cooperation, as evidenced by the fact that no agreements could be made regarding the take-back guarantee of materials and products. In addition, it could be concluded from the case study that in retrospect many parties saw the project as an experiment in which a lot of money was invested. The circular pavilion appears to have been an expensive project in which the predetermined goal, that it must also be feasible for others, was not achieved. Nevertheless, the end result is a beautiful building built according to the principles of circular economy but it can also be concluded that it is not an example of what the process of circular business model innovation in a business ecosystem should look like.

Table 8 - Influence of the factors in the three phases of the process (case study) (own illustration, 2018)

Phase	IDEA (phase 1)	DEVELOPMENT (phase 2)	IMPLEMENTATION (phase 3)
Factor			
Requirement of a Lead Company	+	+	-
Trust in partner collaboration	-	+	-
Strategic thinking	+	+	-
Absorption capacity	0	+	-
Interdependence	0	+	-





6. Conclusion

In this chapter, the central research question is answered. The main research question was as follows:

How does the process of a circular business model innovation (CBMI) take place in a business ecosystem for the construction sector?

To answer this main-question (MQ), the sub-questions are answered first. Six sub-questions were formulated for this research that provide the basis for answering the main research question. The first five sub-questions have been answered through literature research. In the sixth sub-question, an attempt was made to describe the success and failure factors of circular business model innovation in a business ecosystem on the basis of existing literature and to determine the impact of this by means of empirical research.

6.1 Sub-questions

1. What is the circular economy?

The circular economy offers an answer to the major challenge in the 21st century to deal with raw materials much more efficiently. Since the industrial revolution, the economy has been dominated by a take-waste-dispose model. This linear economy has waste as an outcome. A circular economy is a system which is restorative and regenerative by design, aiming to minimize the entrance of new materials into the production process, as well as to eliminate the corresponding created waste. The Ellen MacArthur Foundation (2013a) presents five circular principles to operationalize the concept of circular economy: design out waste, build resilience through diversity, shift to renewable energy sources, think in systems, and think in cascades (waste is food). Based on these principles, different ways of closing the loop are created where the concept tries to prevent the unnecessary use of raw materials and keep the value of materials as high as possible. The biological cycle is based on non-toxic materials that can be restored back into the biosphere. The technological cycle is about keeping products at their highest value and consist of; lengthening the lifecycle, reuse/redistribute, refurbish/remanufacture, and recycle.

2. What does the circular economy encompass for the construction sector?

The construction sector is a resource intensive sector which is responsible for a lot of raw material use and waste generation. The big challenge in the construction sector is to use these raw materials in a high-quality way because the now common recycling largely destroys the added value of building materials and reduces them to the value of the raw material. So, there are various reasons why it is necessary that the construction sector need to move towards the circular economy (CE): the construction sector is by far the largest consumer of raw materials worldwide, the impact on people and the environment is big, demand for raw materials in general and building materials in particular is increasing, materials become scarcer and price fluctuations are bigger and with the current way of building, materials already 'lost' in advance. This transition to the CE for the construction sector takes places in two areas, namely in the field of design, technology and logistics and the second one reflects on the business models for circular economy. In terms of technology it is important for the transition to a circular construction sector to design and built differently, according to circular principles and with circular materials. In addition, in the construction sector, the implementation of the circular economy depends on collaboration between parties to realize a circular project. If these parties have the same goal and work together, they can strengthen each other and accelerate the transition.



3. How is a circular business model for the construction sector set up?

The transition from linear to circular construction sector will have an impact on the business model because the business community can simply not support that circular concept impose. Therefore, new the circular business models (CBM) are needed which closes cycles, create collective value and shares these collective values. The difference between a business model (BM) and a circular business model (CBM) is that a CBM should be regarded as a subcategory of BM's which fit in an economic system of restorative or closed material loops. A circular business model is the rationale of how an organization creates, delivers and captures value with and within material loops. These CBM are characterized by: closing raw material chains, transition from products to services and better use of the functionality of the products. These characteristics can be translated into a number of generic buildings blocks which can be characterized for all circular business models: Realization of cycles, striving for value creation, choose an appropriate strategy, design an organization that fits with the between-parties-organization and developing revenue models.

4. What is circular business model innovation?

The need for business models (BMs) in order to implement circular economy (CE) has been widely expressed and is regarded as one of the key obstacles for successful implementation of CE (EMF, 2015). These so-called circular business models (CBM) can be implemented through the circular business model innovation (CBMI) process. CBMI can be defined as a new way to create and capture value, which is achieved through a change of one or more multiple keystones in the business model to move toward the circular economy. The goals and scope of a CBMI process can vary greatly because CE targets at company level differ from the targets at system level, called the business ecosystem level. The re-design of business ecosystems is the big challenge in CBMI because a win-win situation should be created that balances the interests of the actors involved and therefore influences and facilitates their actions in order to give shape to the circular business model in a coordinated way. In addition, circular business models do not need to close material loops within its internal system boundaries, but can also be part of a system of business models that together form a material loop to be considered 'circular'. The network plays a central role here, so CBMI requires cooperation, communication and coordination within complex networks of interdependent but independent actors/stakeholders.

5. What are Business ecosystems?

Companies are increasingly being given the opportunity to build benefit by joining together in networked ecosystems or business ecosystems. By introducing an eco-system strategy, companies can respond to the global trends/problems that no individual organization can solve. The necessity of the transition to the circular economy arose from such a global problem. Business Ecosystems are dynamic and co-evolving communities of diverse actors who create and capture new value through ever better collaborations and competition. Business ecosystems captures three core characteristics. First, ecosystems create and stimulate the participation of large and small organizations (**Symbiosis**). The second characteristic is that actors that are part of the ecosystem communicate and co-create in ever more sophisticated ways by using technologies and tools of connectivity and collaboration that are still proliferating and disseminating (**platform**). Thirdly, participants/customers are connected through a combination of shared interests, goals and values that encourage them to collectively nurture, sustain, and protect the ecosystem (**Co-evolution**). In addition, it can be concluded that innovation in alliances and networks is gaining in popularity, and trends such as technological disruption, the rise of corporate venturing and entering into alliances mean that innovation must increasingly take place within chains or networks. This also applies to the current transition to the circular economy that can be considered in this context as the innovation in question. The process of



such an innovation in a business ecosystem consists of three phases, namely; phase one the emergence of an idea, phase two the development, and phase three the implementation.

6. Which success and failure factors plays a role for a circular business model innovation in a business ecosystem?

The success of a circular business model innovation in a business ecosystem depends on several factors. In this study the most important factors are described on the basis of literature research, after which their influence is determined on the basis of empirical research. The success factors that play a role are explained below.

- Requirement of a lead company:

The research shows that the lead company has an important role to play in all three phases of the innovation process in the ecosystem. However, the role differs from phase to phase or the emphasis of a particular role differs. This is in line with the literature, namely that the sum of these actions creates a successful business ecosystem and thereby stimulates successful innovation in an ecosystem. The first role is to point out the value creation. In the case study, the lead company has a clear vision of the possible value creation, although it can be said that this vision was not very clear in the first phase. The second role is to involve the partners. The investigation has shown that this has an important role to play in phase two and three, because from that moment on partners are involved who must have the same ambition. The third role is to create and promote trust and knowledge sharing. The research shows that this plays an important role in phase two and three. For example, mutual trust is important for cooperation because a lot of money, time and knowledge is invested. Finally, the lead company has a role in promoting co-creation. This plays a role especially in the second and third phases because most of the parties are added to the business ecosystem in order to realise a circular building together. It can also be concluded that after the realisation of the pavilion, the business ecosystem collapsed. The case study showed that, in the implementation phase, the absence of the influence of a lead company contributed to this.

- Trust in partner collaboration:

The research shows that trust in all three phases plays an important role in the success of innovation in a business ecosystem. The case study showed that the absence of trust in partner cooperation in phase three meant that it was not possible to make proper agreements which had a negative impact on the success of the business ecosystem. Mutual trust is of great importance for the success of the project and for innovation in the business ecosystem. In phase two this was present. This can be concluded from the fact that the various parties in the ecosystem continue to invest in time, money and knowledge while the process was stopped in the first phase. Literature shows that trust in a partnership plays an important role and that as a result a positive attitude towards each other is developed. The case study also showed that the control mechanism for culture plays an important role in all three phases, whereby in phase three these cultural differences could no longer be managed, as a result of which trust in partner cooperation disappeared.

- Strategic thinking

The case study shows that there is a clear vision and strategy in all three phases of the innovation process in the ecosystem. This vision and strategy is leading for the innovation process but they play different roles in the three phases. In the first two phases, it plays a role for pitching the idea and ensuring that everyone has the same idea. In the third phase the vision serves more as a guide, where everyone can fall back on decisions and/or problems. Literature also shows that strategic thinking is



important for the success of a business model innovation in a business ecosystem, because the challenges, such as learning how to turn risks and challenges into targeted actions, require strategic thinking. The case study showed that strategic thinking was only present during the realization of the pavilion, but that this subsequently disappeared because long-term orientation had disappeared, which is an important characteristic of strategic thinking. This was because the parties could not make any firm agreements with regard to take-back guarantees, etc. The absence of this success factor in the third phase was one of the reasons why the business ecosystem collapsed.

- Absorption capacity

The case shows that absorption capacity does not play a major role in the first phase. However, it does play an important role in phases two and three. In phase two, this is apparent from the fact that specific knowledge of various parties is added to the total product of the realisation of the circular pavilion. In phase three, the absence of absorption capacity appears to be due to the time pressure of the project. There is no time to develop and test innovations, which meant that people were more limited in making certain choices. The literature agrees that absorption capacity is important for the success of a business model innovation in a business ecosystem, as the lack of absorption capacity is an obstacle to the effective implementation of innovative ideas.

- Interdependence

The case study shows that the lack of interdependence in phase three led to the business ecosystem not being able to sustain itself and falling apart. In the second phase, this interdependence seemed to exist. In this phase, all parties in the ecosystem added value to the development of the pavilion. The various parties that took part knew what their contribution was to the whole. They were interdependent because each contributed to the total value. In phase three, after the realisation of the pavilion, all mutual dependencies actually disappeared. Where the parties needed each other during the realisation they turned out afterwards to regard this project as an experiment and no agreements could be made for the long term. In addition, the case study has shown that, in a sector such as construction, it is simply very difficult to get the parties to agree to be interdependent. However, this is an important success factor for an innovation in a business ecosystem.

6.2 Main question

How does the process of a circular business model innovation (CBMI) take place in a business ecosystem for the construction sector?

Literature shows that the process of circular business model innovation in an ecosystem takes place in three phases: idea, development and implementation. The empirical research shows that these three phases can also be distinguished for the case, but it can be concluded that the business ecosystem has fallen apart because especially in the implementation phase (phase three) different success factors were no longer present. As a result, there seems to be little difference between a traditional project organisation and the business ecosystem as configured in chapter 5.

The first phase (idea) is characterised by various attempts and setbacks to let the idea take form. For example, a radical decision was made to halt the process at this stage, because the lead company felt that it did not have the same ambition and vision as the parties involved in the business ecosystem. The process is not a structured process that can take up a lot of time. After all, the lead company continues to look for the right way to express their vision and ambition to the participants of the



business ecosystem. Garud endorses this, as described in section 3.4.3., namely that there is a long period before new ideas emerge and that innovation processes do not take place in structured steps.

The second phase (development) concerns the development. In this phase, having a good idea was important. To develop the idea into a circular business model to eventually realize a circular building is a major challenge that requires the commitment of the parties in the ecosystem. This is supported by literature. Moreover, the case study showed that this also caused the necessary friction between the parties. It can also be said that in the case the development phase and the implementation phase were almost parallel, because many of the choices could only be made in the implementation phase. The reason for this was that during the implementation phase the parties were able to better assess what was possible because building according to the principles of the circular economy was new for many of them.

During the third phase (implementation), the business ecosystem realises the circular pavilion. After realization, all interdependencies actually disappeared. The interviews revealed that the project ultimately turned out to be a commitment between people rather than between parties, as a result of which the ecosystem fell apart too easily. Where the parties needed each other during the realization they turned out to consider this project as an experiment. In addition, it can be concluded that, in a sector such as construction, it is simply very difficult to get the parties to agree to be interdependent. However, this interdependency is according to literature an important success factor for an innovation in a business ecosystem. Finally, the lead company had set the goal in advance that the project also should be feasible for others. In the end, it can be concluded that the project was not profitable. The financial investments were high so building according to the principles of the circular economy did not lead to a revenue stream which is a keystone of a business model. Therefore, we can state that the circular business model innovation in the business ecosystem has not succeeded. According to Garud (section 3.4.3.), additional steps must be taken during the implementation phase to actually bring the potential innovation forward, but this turns out not to have happened in the case.

In short, ABN AMRO's ambition was to enter into long-term partnerships with parties in order to contribute to the transition to the circular economy. The circular pavilion was to be a first step in this direction, after which more circular real estate would have to be realised and perhaps new markets could be created as a result. This can be placed in the context of a business ecosystem in which different parties work together to be innovative and in which social problems are also tackled by means of co-evolution. However, it has become apparent that in the implementation phase the business ecosystem falls apart after the first project has been realised in accordance with the principles of the circular economy and therefore the circular business model innovation in a business ecosystem has not been successful. Despite good initiatives such as the construction of the circular pavilion, the construction sector appears to be a stiff sector that is difficult to get out of its traditional column.



7. Discussion

In this discussion, the results of the conclusion are reflected. The aim of this research was to provide insight into how the process progresses from a circular business model innovation (CBMI) in a business ecosystem. The findings of this study are based on qualitative research using unstructured interviews. Specific insights have emerged about how an ecosystem develops in the process and which factors influence the success of a CBMI in a business ecosystem. The success factors of the CBMI in a business ecosystem were identified through existing literature and validated through empirical research. This increases the internal validity of the results. The external validity of this exploratory research is low. However, as the study was exploratory, the results are not intended to be generalized to other cases. The transition to the circular economy can be accelerated by cooperation between different parties. This research therefore specifically looked at factors at the level of the business ecosystem, giving this insight to the total system level instead of at company level. The research has shown that circular business model innovation at ecosystem level creates a different dynamic than a circular business model innovation at company level.

Due to the novelty of circular economy, this concept is currently still quite immature. Therefore, in the current market it is very difficult to build according to the principles of the circular economy. An important reason for this is that the practice indicates that many parties are not yet ready to build circularly and have no idea how to approach this. Because of this, the risks are often high and prefer to stick to the traditional way of building. In addition, this immaturity of the concept was also substantiated by the fact that suppliers were not prepared to guarantee the repurchase of products because they could not assess the possible state of products after a possible demolition. Hard contractual agreements could not be made about this.

From this study, it was concluded that the case investigated was not a successful circular business model innovation (CBMI) in a business ecosystem. Many of the success factors that needed to be present for a CBMI in a business ecosystem simply did not exist in certain phases. Therefore, the business ecosystem had fallen apart according to the realization of the project. As a result, it looks more like a traditional project organisation than a business ecosystem that actually wants to enter into long-term collaborations in order to contribute to the transition to the circular economy. If ABN AMRO or another organisation really wants to make a commitment to a transition to the circular construction sector, the long-term orientation should be better facilitated, for example by contractually establishing long-term partnerships. A business ecosystem then ensures that the parties work together on a transition to the circular economy instead of traditional realization of a project, after which everyone leaves again.

The research also revealed that many parties saw the project more as an experiment. An experiment from which a lot of lessons could be learned and from which a lot of new insights were gained, but in which the process cannot be applied directly to other projects because building according to the principles of the circular economy at the moment costs more money than building in traditional way. The circular pavilion appears to have been an expensive project in which the predetermined goal, that it must also be achievable for others, was not achieved. The priority to build circularly weighed more heavily than the costs, so often not the cheapest choices were made, but the choices that scored high on circularity. ABN AMRO had the opportunity to do this because they made a lot of money available for this type of initiative. These are, of course, very good initiatives to bring circular building to the attention of the public. Therefore, initiatives such as Circl should be taken more often because the transition to the circular construction sector is necessary, and we are all responsible for this.



Due to the novelty of the circular economy, this concept is still relatively immature at the moment. Therefore, in today's market, it is very difficult to build according to the principles of the circular economy. An important reason for this is that practice has shown that many parties are not yet ready to build circularly and have no idea how to tackle this. As a result, the risks are often high and they prefer to stick to the traditional way of building. In addition, this lack of maturity of the concept was also supported by the fact that suppliers were not prepared to guarantee the buy-back of products because they could not estimate the possible state of products after possible demolition. No contractual arrangements could be made here. In addition, in the case it turned out to be simply difficult to let parties be and remain interdependent. The construction sector simply does not seem to be ready for this yet.

The study was intended to provide managers of companies involved in the realization of real estate with insight into how a successful collaboration can be formed to realise real estate according to the principles of the circular economy. However, it can be said that the transition to the circular economy is at an early stage, with the case study showing that the circular pavilion was a project that is not representative of other possible cases. However, it has been shown that much has been learned from this project with regard to circular construction, and so it is certainly a successful project in that sense. These lessons can be fed into new initiatives in this area. In addition, the absence of decisive success factors has had a negative impact on the creation of a business ecosystem with a long-term orientation. Perhaps we are still in a too early stage to facilitate the transition to the circular economy by means of business ecosystems. The literature has certainly shown that there are many advantages to this, but it does need to be validated by practice, but the construction sector does not yet seem ready for this.

Finally, it can be said that the main question was not answered literally because the case study was not a successful CBMI in a business ecosystem and therefore did not provide insight into what a successful process of CBMI in a business ecosystem looks like. Nevertheless, the research has provided new insights such as the factors that are important for a successful CBMI in a business ecosystem, how these factors influence certain phases of innovation and many other insights.

7.1 Recommendation

This research was mainly exploratory, which means that more in-depth research needs to be done. For follow-up research, there are various themes on which this research can be further broadened. In this section, the themes and the associated research directions are described.

7.1.1 Restrictions and future research

First of all, finding the right case was a limitation. In this study we tried to investigate one business ecosystem where a circular business model innovation was implemented in the construction sector. Based on the selection criteria drawn up, a case was finally selected that seemed to fit best in the concepts of the literature review. During the analysis of the case study it became clear that these concepts (circular business model innovation and business ecosystem) are not so easy to translate into a practical example in the construction sector. The immaturity of the transition of the circular economy in this sector plays a major role in this. It is therefore very interesting, for a follow-up study, to look at what lessons can be learned from other sectors where an innovation in a business ecosystem has already proved its worth, such as, for example, the automotive industry. By looking at how the process of innovation in a business ecosystem went in this sector and where the interfaces are for the construction sector.



In addition, this was an exploratory study in which one case was investigated. As a result, the external validity is not strong. For follow-up research it is therefore interesting to carry out a multi case study. By means of a multi case study, more data will become available about possible differences and similarities between the different factors investigated, in order to increase the reliability of the research. This was not possible in this study because it was very difficult to find the right case which was built according to the principles of the circular economy and in which possibly a circular business model innovation in a business ecosystem was applied.

The case study investigate the process course over a long period and is based on individual interpretations of the respondents. These individual interpretations may have influenced the results. A longitudinal investigation of the entire research period would give a better picture but is practically not feasible in view of the long period of the process in an ecosystem. Another problem is that it is difficult to identify a previously unknown ecosystem, making longitudinal research practically impossible. However, this type of research would be good to gain a broader insight into the development of circular business model innovation in an ecosystem.

In this research unstructured interviews were used, as a result of which not all concepts were specifically discussed. This has influenced the quality of the empirical data. In order to gain more depth in the research, a second round of interviews had to take place in order to verify and validate the data found. This did not occur in this study due to the limited availability of the respondents and the practical feasibility of the research.

Finally, it is very interesting to carry out follow-up research into the drawing up of contracts for long-term cooperation between parties in order to promote the transition to the circular economy and to look at how contractual agreements can be made with regard to the take-back guarantee for products and materials. From the case study it became clear that such agreements could not be made because building according to the principles of the circular economy was new for many parties and therefore they did not want to take this kind of risks.



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Appendix A: Case selection

Cases	Criteria: circular building	Rating (+/+ +/+++)
Case 1 Renovation of town hall of the municipality of Eindhoven	The renovation of the city hall tower is part of the sustainability of seven municipal buildings in Eindhoven. Therefore, this is a sustainability project in which 95% of the material from the city hall tower has been reused. Reuse is part of the circular construction but is not central to this project. In circular construction, the aim is to build following the principles of the circular economy and so we cannot qualify this city hall tower as a circular building after renovation.	+
Case 2 Head office Alliander 'Bellevue'	The building design during the renovation of the Alliander head office was realized based on the principles of circular economy. Thomas Rau (architect of this project) says that the building is a depot of reusable building materials.	++
Case 3 Circular Pavilion ABN AMRO (Circl)	Circl is seen as the example for the circular building of the future. It is built according to the principles of the circular economy.	+++
Case 4 Townhall Brummen	A concept for a circular building was devised for this project: a city hall as a raw materials depot that can be disassembled after the use period.	++

Cases	Criteria: implemented a CBMI together	Rating (+/+ +/+++)
Case 1 Renovation of town hall of the municipality of Eindhoven	The long-term cooperation signed for the renovation of seven municipal buildings in Eindhoven is a sustainability project and therefore no CBMI has been implemented. Everyone does, however, care to use materials differently and to reuse them at a high level.	+
Case 2 Head office Alliander 'Bellevue'	During the renovation of the Alliander head office, the circular character of the renovation was visible throughout the renovation period. 80% of the demolition materials have been reused wherever possible within the office or elsewhere. The building design can be completely disassembled and reused. Debris that has been reused as road paving is seen here as reuse, but this is down-cycling because it lost its value and therefore does not fit within the principles of the circular economy.	+
Case 3 Circular Pavilion ABN AMRO (Circl)	During the realization, the goal has been set from the outset to design and realize according to the principles of the circular economy. The traditional architectural sequence was reversed in this project: not first designing and after that looking for suitable materials, but: which materials are available, have a low CO2 impact when it comes to production and transport, and how are they as circular as possible to deploy? This is a good example of circular business modelling innovation.	++
Case 4 Townhall Brummen	Just as with the development of Circl, the realization from the outset was the goal to design and realize according to the principles of the circular economy.	++



Cases	Criteria: Collaboration through a business ecosystem	Rating (+/+ +/+++)
Case 1 Renovation of town hall of the municipality of Eindhoven	This is a collaboration between the municipality of Eindhoven and the IMPULS consortium. This consortium is a collaboration between various parties, including Brink Groep, which share the same goal with each other and that is the sustainability of seven municipal buildings. A business ecosystem does not necessarily only consist of parties from the construction sector and that is the case here.	+
Case 2 Head office Alliander 'Bellevue'	This project was realized through a collaboration involving Alliander, VolkerWessels real estate and architectural firm RAU in the consortium. In addition, there was a co-creation between employees and the consortium.	+
Case 3 Circular Pavilion ABN AMRO (Circl)	Circular building was also new for ABN AMRO and so the partnerships were indispensable. They have worked together with architects, consultants, Delft University of Technology, Mitsubishi and suppliers to realize this project. A business ecosystem traverses industries and in this project this also happens. For example, TU Delft and Mitsubishi have been involved in this project	++
Case 4 Townhall Brummen	In the project of the Brummen city hall, Rau architecten and construction company BAM worked together to realize the project. In addition, there has been cooperation with other parties because agreements have been made to take back the valuable raw materials and building elements after use by their suppliers and manufacturers.	+

Cases	Criteria: There is a Symbiosis, platform & co-evolution	Rating (+/+ +/+++)
Case 1 Renovation of town hall of the municipality of Eindhoven	There is a symbiosis because the consortium consists of a loose network of companies that apply co-evolution because everyone proceeds to reuse materials of high quality. IMPULS and the municipality of Eindhoven offer materials for reuse on the website (platform) 'Resource Store'.	++
Case 2 Head office Alliander 'Bellevue'	It can be said that there has been a co-evolution because the architect and the contractor have put the circular ambitions of Alliander into practice. Whether or not a particular platform has been used for this design is not clear	+
Case 3 Circular Pavilion ABN AMRO (Circl)	This project itself is a platform for sharing knowledge about circular economy and thus stimulating the transition to the circular economy. In addition, there is co-evolution because everyone with ideas in the field of circular economy can come to the Circl to share this with each other. A Symbiosis is also created because a separate network is created between the interested parties.	++
Case 4 Townhall Brummen	For this project the Turntoo platform was used to realize this project. There was not a symbioses present that could provide for co-evolution.	+



Case	Sources:
Case 1 Renovation of town hall of the municipality of Eindhoven	http://www.impulsgeeftenergie.nl/vrijkomende-materialen-renovatie-stadhuistoren-krijgen-tweede-leven/ https://www.ed.nl/eindhoven/gemeente-eindhoven-95-materiaal-uit-stadhuistoren-is-hergebruikt~a4238e1d/#comments-anchor
Case 2 office Alliander 'Duiven'	https://www.rvo.nl/initiatieven/energiezuiniggebouwd/alliander https://www.rvo.nl/actueel/praktijkverhalen/alliander-kantoor-duiven-volledig-circulair-gerenoveerd
Case 3 Circular Pavilion ABN AMRO (Circl)	https://circl.nl/themakingof/ https://www.bambouwentechniek.nl/projecten/circulair-abn-amro-paviljoen-amsterdam-circl
Case 4 Townhall Brummen	https://architectenweb.nl/nieuws/artikel.aspx?ID=32190 https://www.nrc.nl/nieuws/2013/09/19/over-20-jaar-schroeven-we-dit-weer-uit-elkaar-we-dit-1294034-a1120556



Appendix B: Interview guide

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Appendix C: Outcomes interviews

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