Implementation of Circular Business Models in Firms: Prospects and Barriers
Implementation of Circular Business Models in Firms: Prospects and Barriers

By

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Executive summary

Problem: The appearance of circular economy has been raised as a solution to rapidly diminishing resources and waste issues that constant economic growth entail. The transition from the current linear economy in which we take, make, use, and dispose of resources to a circular economy in which waste becomes raw material is expected to close material loop. To advance the era of the circular economy and foster the participation of companies, understanding circular business models is essential. Therefore, this research seeks answers to the question “How to facilitate the implementation of circular business model at a firm-level?”. For this purpose, the literature review and the case study is used to complete the theoretical and practical aspect of the research.

Literature review: The first half of the literature review provides a theoretical background of this study looking into the core concepts of the research such as circular economy, business model, and circular business model. The second half of the literature review is about business modelling tools for general and sustainable business models. The result of the review is used as an input for building the framework for the case study.

Case study: This research studied three cases of circular business models (CBMs). The companies that use resource-based CBMs and bulk waste and deal with business customers were selected. Black Bear Carbon generates carbon black from used tires, DSM NIAGA provides carpet machines and adhesive that enables the production of 100% recyclable carpet, and Van Houtum generates toilet paper from used paper. Prior to the case study, five interviews were conducted with experts in academia, a consultancy firm, scientific network, and government organization. The results of the interview were used as an input for the establishment of the case study strategy. The three cases were studied using desk search and interviews based on the case study framework and five dimensions of CBM: circular value, value network, value proposition, architecture, and finances.

Case analysis: The results of the case study were analyzed separately and then cross-checked. The analysis shows that companies find circular values in the economic and environmental aspects. In the value network of companies, diverse types of relationships are observed depending on the strength of relationships between actors. A large overlap was observed in the values offered for customer, environment and society. The analysis of the finance aspects showed that the cases have a similar revenue and cost structure but a different pricing method. The positive and negative impact of the current legislation is compared in the value architecture, followed by the different
use of business modelling tools. The main success factor is found in the establishment of new value network and the main challenge is found in making a change in the existing network.

Discussions and conclusions: The findings of this research are threefold: (1) the concept of upcycling is one of the elements that defines a CBM, (2) the most critical factor for the success of CBM is the formation of a circular value network, (3) the business modelling tools for CBMs should emphasize the element of circular values. This brings the theoretical contributions to the definition of CBM and developments of the business modelling tools for CBMs. The practical contributions are made to the firms who are considering implementing a CBM as a reference book. Lastly, policy makers can use this research as a guideline on the revision or reformation of the waste policy and legislation.

This report contains confidential company information. Therefore, this report is published in a public and internal version. Some contents are edited or eliminated in the public version of this report.

**Keywords:** Circular Economy, Circular Business Model, Waste to Material, Material Recovery, Value Network
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<td>Business to Business</td>
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<td>BBC</td>
<td>Black Bear Carbon</td>
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<td>BM</td>
<td>Business Model</td>
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<td>BMC</td>
<td>Business Model Canvas</td>
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<td>CBM</td>
<td>Circular Business Model</td>
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<td>CE</td>
<td>Circular Economy</td>
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<td>CSR</td>
<td>Corporate Social Responsibility</td>
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<td>DN</td>
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<td>ELT</td>
<td>End-of-Life Tires</td>
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<td>PSS</td>
<td>Product Service System</td>
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Introduction

1.1. Research problem
1.2. Research objective and question
1.3. Research structure
1.1. Research problem

The Industrial Revolution opened the era of mass production, and products became faster and easier to manufacture, access, and purchase than ever. The development of technology, various means of marketing, and globalization facilitated the consumption of goods. A fast-growing world population and economic growth have rapidly increased the consumption of resources. Furthermore, the appearance of emerging countries has been accelerating the phenomenon as well as its environmental impact. The extensive use of resources led to multi-dimensional consequences, such as climate change, the soaring prices of raw materials, the exhaustion of natural resources, and environmental pollution.

Industries were urged to seek new sustainable ways to carry out business. Some firms pursued sustainable solutions further than legal requirement as parts of corporate social responsibility from a philanthropic perspective. Lately, an increasing number of firms integrate sustainability into their business models, providing new value propositions for customers and encouraging innovation and higher economic performance (Bocken et al., 2014; Boons et al., 2013). However, the sustainability levels of a majority of firms have hovered around the minimum requirements of government regulations.

While pursuing sustainability is generally perceived to go against the profitability of firms, resource efficiency, one of the principles of sustainability, has drawn the attention of firms because it can promote sustainability and profitability. The improvement of resource efficiency was formalized into a concept called circular economy (CE) and integrated with business models that support the closing of a material loop (Jensen & Remmen, 2017). A CE focuses on the circularity of resources compared to the current linear systems represented by the take-make-dispose process. The core of the concept is capturing value from what is considered to be a waste and seeing waste-as-food so that there is no waste (Bocken et al., 2016; Murray et al., 2017).

![Figure 1. From Linear Economy to Circular Economy. Author’s creation](image-url)
The transition from a linear economy to a circular economy cannot be accomplished without participation from industries. Industries are the most vulnerable actors concerning the problems that the current linear system is causing. They are also the largest beneficiaries from the transition from both short- and long-term perspectives. Firms with CBMs can earn immediate and direct gains by generating value from waste. There are strong motivations for firms to implement circular systems.

To induce industries to move forward in the CE, having a clear, direct, and visible business model is critical because profitability is one of the primary goals of firm activities. Therefore, theoretical and practical research on CBMs is important. However, CBM is a relatively recent concept, and there is a lack of knowledge and experience in both academia and industry.

1.2. Research objective and question

In this research study, the author aims to support the formulation, adoption, implementation, and improvement of CBMs in easy, efficient, and effective ways. Discovering the prospects and barriers of CBM and sharing knowledge with firms and to different parties in society is expected to facilitate the dissemination of CBMs. Because firms with CBMs are mainly in the business-to-business sectors, this research provides an opportunity for firms to be exposed and share their knowledge and experiences. This will be an opportunity to learn from their experiences in the implementation CBMs and what accords with the expectation and what does not. Through this research, firms can make effective strategic decisions in the pursuit of CBMs, and ultimately, it will attract more firms to participate in the CE. To achieve these goals, this research seeks an answer to the main research question which is formulated as follows:

How to facilitate the implementation of a circular business model at a firm-level?

To answer the main research question, three sub-questions were formulated:

Sub-question 1. What is the current state of CBMs?

The concept of CBMs is relatively new and has a broad range with unclear boundaries. Through this question, this paper tries to explain how CBM is understood in the literature and in practice, and how to classify different types of CBMs breaking them down into several categories that are clear and practical so that are useful in practice.
Sub-question 2. *What are the success factors and challenges in the implementation of CBMs by firms?*
Understanding the success factors and critical issues of CBMs and finding out the elements that drive those issues are essential to the implementation of CBMs. These factors require attention through the whole cycle, from the preparation stage to during and after the implementation of a CBM.

Sub-question 3. *What recommendations can be made for the development of business modelling tools for CBM?*
Business modeling tools can be helpful when firms start to implement new business models or make modifications to existing ones. However, because CBMs are used to pursue different goals than normal, linear business models, it is meaningful to discover what business modeling tools have been used by firms with CBMs and what factors are missing in the existing tools.

1.3. Research outline

In the following chapter, a thorough literature review is presented to provide the fundamental knowledge and theoretical background of the core concepts. The definitions, perspectives, examples and applications of CE, CBMs, and business model tools are elaborated on.

In the third chapter, the core methodologies used in this research are described. To begin with, in the research framework section, the author describes the conceptual and sequential flow and detailed steps of this research. Following descriptions of the framework and the selected methods (expert interview and case study) are provided to explain the relevance to this research. After that, the data collection design that was optimized for the methodology is explained.

In the fourth chapter, the author analyses the cases of three existing companies with CBMs. The results of Chapter Four are cross-analyzed using five factors in Chapter Five. In the sixth chapter, the findings of the research are elaborated in different aspects and the business modelling tool for CBM is discussed. The last chapter concludes this research by elaborating the scientific and practical contributions, recommendations, limitations and suggestions for the future research.
Literature Review

2.1. Circular Economy
2.2. Business Model
2.3. Circular Business Model
2.4. Business Modelling Tools and Frameworks
2.5. Business Modelling Tools and Frameworks for Sustainable Business Models
2.6. Conclusion
The main question of this research is about the implementation of circular business models, which contains several key concepts that should be looked into separately. Firstly, the ultimate goal of pursuing CBMs is to achieve a CE. Understanding what a CE is and the discussions around it provide a blueprint for the future that is to be achieved through this research. Secondly, to understand what a CBMs is, the definition of a general business model is reviewed. In the following sub-chapter, how circular values are applied to business models is analyzed to understand what CBMs are and the different types of CBMs. In the fourth sub-chapter, several business modelling tools and frameworks that are available for general business models are reviewed to gain an understanding of the elements, aims, and outcomes of the tools and how they help in the implementation of business models. The following sub-chapter provides a review of the business modeling tools and frameworks for sustainable business models, emphasizing sustainability of business models. Because there are no business modeling tools specifically focused on circular values, the tools for sustainable business models were chosen for analysis. Lastly, the author elaborates on the relevance of this literature review for the research in the conclusion.

2.1. Circular Economy

In the current linear economy, the existing pattern of consumption cannot keep up with the increasing demand for resources. Therefore, changing from a linear economy to a CE is considered to be the most feasible way for continuous economic growth and sufficient amounts of resources for consumption to coexist. The Ellen MacArthur Foundation (2015), the leading organization in research and penetration of CE worldwide, defines CE as “an industrial economy that is restorative or regenerative by intention and design.” The foundation presents a butterfly diagram that distinguishes between technical and biological cycles in a CE, as shown in Figure 2. The technical cycle involves recovering and restoring finite materials, and the biological cycle encompasses the flows of biological materials that are regenerated in the cycle. Before the appearance of CE, there were few terms that described similar concepts. The term “industry ecology” has been used as a synonym for “circular economy,” as well as other related concepts, such as “cradle-to-cradle,” “closed-loop,” “biomimicry,” and “blue economy,” emphasizing the circularity of resources (Lieder & Rashid, 2016; Geissdoerfer et al., 2017; Ghisellini et al., 2016; Benyus, 1997). Cradle-to-cradle (C2C) goes beyond the circularity of materials, ensuring the elimination of harmful impacts on the environment by not using toxic materials, the usage of more organic materials, as well as the use of renewable energy in production (McDonough & Braungart, 2009).
In the literature, the implementation of CE is often viewed from three levels: micro, meso, and macro levels (Lewandowski, 2016; Murray et al., 2017; Ghisellini et al., 2016). The micro level involves the activities of individual firms, the meso level involves eco-industrial parks or industry symbiosis, and the macro level involves city, region, or national scales. The 3Rs principle (recycle, reduce, and reuse) is one of the commonly implemented actions in a number of countries (Ghisellini et al., 2016). In India, the use of non-renewable materials is restricted, and non-renewable materials have been replaced by biodegradable, renewable, and recyclable resources (Goyal et al., 2016).

While the literature largely ignores the stakeholders, the key to the transition to a CE is the involvement of stakeholders in suitable collaboration (Ghisellini et al., 2016). Emphasizing the shared responsibility among all stakeholders, including customers, Connett et al. (2011) argue that if a product cannot be reused, recycled, or composted, then the industry should not produce such a product and consumers should not buy it.
2.2. Business Model

The study of business models (BMs) began in 1990s with the appearance of e-business and in early 2000’s, the concept of the business model started to be understood as more general meaning in management literature (Nielsen & Lund, 2014). Literature about BMs shows that there has been disagreement about the definition of BM among scholars. Therefore, BMs are often studied without explicit definitions of the concept (Wirtz et al., 2016; Casadesus-Masanell & Ricar, 2010; Zott et al., 2011).

The term “business model” refers to a description or model that represents a firm’s reasons for creating, distributing, and capturing value for its stakeholders (Haaker et al., 2017). Magretta (2002) and Wirtz et al. (2016) find that business models are used to lead businesses to success as structured management tools or theoretical concepts, which are broken down into components that contribute to decision-making processes. The components that are discussed in BMs are strategy, resources, network, customers, value proposition, revenues, service provision, procurement, and financing. With a combination of the above-mentioned components, a BM is a statement, description, representation, architecture, conceptual tool or model, structural template, method, framework, pattern, business idea, business concept, revenue model, or economic model (Zott et al., 2011; Magretta, 2002). The range of business models in the literature include product-, business-, company-, and industry-level models (Wirtz et al., 2016). There are two different sets of elements in a business model. First, the concrete choices made by management about the operation of the organization, and second, the consequences of these choices (Casadesus-Masanell & Ricart, 2010).

Business models are often compared to or confused with business strategies. In the literature, the two are considered different, even though the concepts intersect each other. Casadesus-Masanell and Ricart (2010) argue that a business model is a direct result of strategy or a reflection of a firm’s realized strategy. According to Dahan et al. (2010), a business model presents a means for the coherent implementation of a strategy, and Hamel (2000) finds that core strategy is a central component of any business model.

According to Chesbrough and Rosenbloom (2002), the functions of a business model are “to articulate the value proposition, identify a market segment, define the structure of the value chain, estimate the cost structure and profit potential, describe the position of the firm within the value network, and formulate the competitive strategy.” Magretta (2002) argues that a BM begins with a hypothesis that is tested in action and revised when necessary.
2.3. Circular Business Model

The successful development of business models based on the pursuit of a CE is critical in the dissemination of the concept. Obtaining tangible economic benefits through improved resource efficiency becomes feasible through CBMs. Lewandowski (2016) finds the core component of CBMs is the value proposition and defines CBMs as “the conceptual logic for value creation is based on utilizing the economic value retained in products after use in the production of new offerings.”

The Ellen MacArthur Foundation (2015) presents the ReSOLVE (regenerate, share, optimize, loop, virtualize, and exchange) framework, a tool with which to generate circular strategies aiming less production by sharing and virtualizing, less material use by optimizing material loop, and more renewability by regenerating and exchanging materials. Bocken et al. (2016) find two types of strategies for the cycling of resources, slowing and closing resource loops. Slowing resource loops is related to reuse and repair and realized by designing goods with long lifecycles and product life-extension. Closing resource loops is related to recycling to close the loop between post-use and production.

![Value Hill: a circular business strategy tool (Achterberg et al., 2016)](image)

The value hill is a circular business strategy tool that Achterberg et al. (2016) present to guide firms regarding how to position their businesses and develop strategies in a circular context. The value hill describes the path of a product in three phases in terms of the value of a product. The pre-use phase is an uphill process whereby product value increases through a circular business strategy. The top of the hill, where a product has the most value, is the use phase in which an optimal use business strategy can be applied. In the post-use phase, the downhill part, the product loses its value, and value recovery business strategies slow down the devaluing process. Achterberg et al.
(2016) argue that current linear business models give incentives to design products with short lifespans because their revenue structures are sales-oriented; the more they sell, the more they earn. On the contrary, CBMs are designed to prolong the use phase and slow down the post-use phase. The authors also provide an overview of the circular partners and emphasize that collaborations are essential to the success of a circular value network.

Similar to the value hill, Carra and Magdani (2017) grouped multiple circular business models into three categories, circular design, circular use, and circular recovery models while introducing CBMs in the construction sector. While the three categories have different impacts from social, technical, and financial standpoints, they are expected to interact and work together.

De Haes et al. (2016) propose five revenue models for CEs: circular supplies, resource recovery, product life-extension, sharing platform, and a product as a service model. In the circular supplies model, fully recyclable and biodegradable materials are sourced for production and consumption. In the resource recovery model, resources and by-products are reused, upcycled, or used for energy generation. The product life-extension model suggests repairing, remanufacturing, or re-commercializing capital-intensive products that have high performance after the process. The sharing platform model allows for the optimal utilization of products and services by providing an intermediary role for users. In the product as a service model, companies retain their ownership of products and users pay for the service through lease contracts or rental fees.

Figure 4. The Five Revenue Models of Circular Economy (De Haes et al., 2016)
Kemps and Vos (2016) take new consumer needs as a starting point for circular business in the Dutch automotive industry. Moving from the policy push to the consumer pull, strong consumer demand and trends drive firms to innovate. To meet the new needs of consumers, such as car-as-a-service demands, new strategies are required for product development and restructuring supply chains through collaboration across the entire value chain. Kemps and Vos (2016) look into circular principles that can be applied in the automotive industry: the use of recyclable and low impact materials, the design of products for disassembly, the use of smart systems, lifetime extension, the revision and upgrading of parts, take back, parts recovery, and recycling and upcycling.

Where is the circularity?

The circularity of resources exists in different forms in CBMs. One of the characteristics of current CBMs is variety in terms of the range of circularity and the actors involved in it. Therefore, it is difficult to easily visualize the circularity in each business model. Identifying circularity in CBMs would help firms to make effective strategies with which to optimize their BMs and help other companies identify their opportunities. This research, therefore, proposes three different scopes of circularity with which to classify CBMs. The first type, proximity-based circularity is the circularity in the industrial ecosystem where resources circulate among nearby firms. The ease of resource exchanges can benefit firms that circulate resources in the same complex or region. The firms in the loop do not have to be in the same industry. They are likely to be in different industries because waste from one industry may be a resource in another. The second type of circularity, resource-based circularity is the circularity in a firm’s stakeholder network, which includes suppliers, logistic companies, customers, and sometimes even competitors. After their usage lives, products go back to another actor in the loop and become resources in the loop again. The third type of circularity is ownership-based circularity, which is the circularity exclusively between the firm and its customers caused by the shift of the ownership of products from end users back to producers. This shift enables products to return to the producers after their usage lives. Even though the three different types of circularity have different principles, strategies, and actors, some overlap is inevitable because the three types are not contrary to each other.
Proximity-based Circularity

In proximity-based circularity, resources circulate in a loop among the firms located in close proximity. The firms in the loop have symbiotic relationships; waste, such as by-products from a manufacturing process, can be resources for another company. As resources flow from one industry to another, the planning and organization of proximity-based circularity are managed above a single firm’s organization level, in a cluster or complex level. The most common type is industrial symbiosis that deals with local and regional economies in which multiple firms closely collaborate.

According to Winans et al. (2017), similar concepts are called “eco-cities,” “eco-industrial parks,” or “eco-industrial networks” in different countries. Different countries have different approaches, such as the policy-driven approach in China and the industry-driven approach in the Netherlands. An example of the latter case is the eco-industrial park in Kalundborg, Denmark, which was self-organized based on the economic feasibility through bilateral agreements among industries. While the eco-park in Kalundborg benefits from the material flow exchanges between industries, the Rotterdam Harbor Industrial Ecology Project in the Netherlands aims to reduce heat and CO2 waste through recycling. This project was also initiated by industry actors and later inspired other countries to support the concept through policy (Winans et al., 2017).
Chertow (2000) sees the key point of industrial symbiosis or industrial complex as the synergistic possibilities offered by geographic proximity. Bocken et al. (2016) describe industrial symbiosis as the closing of loops in the macro scope, by which products are recycled via an entirely independent network based on proximity.

**Resources-Based Circularity**

In resource-based circularity, the circularity exists in the stakeholder network of a focal firm. Because the network consists of diverse stakeholders, various business models exist. It includes traditional strategies, such as the 3Rs principle: recycle, reduce, reuse. Bocken et al. (2016) find that recycling in a CE means closing the loop between post-use waste and production. Firstly, recycling, the core concept in the micro scope, extends resource value, such as by reusing materials in manufacturing processes within a production facility. Dajian (2004) argues that the recycling of materials can be divided to closed-loop and opened-loop recycling. In closed-loop recycling, post-use waste is recycled into new products of the same type, such as aluminum can to aluminum can. It reduces the amount of virgin materials used to make a product by up to 90 percent. In opened-loop recycling, waste is converted into different products, in this case, reducing the use of virgin materials by only 25 percent, at most.
In the case of resource-based circularity, a product and its manufacturing process are designed with disassembly and recycling in mind. The optimization of the product and process design for long lifespans and end-of-life treatment include several considerations, such as ease of repair, additive manufacturing, and takeback strategy from end users. It is considered expensive due to the initial investment in the design of products and product lines. In the past, end-of-life treatment has been considered mostly in heavy industries involving large volumes of materials, such as the airplane or vehicle industries. However, the interest in small consumer goods has been increasing (Jensen & Remmen, 2017). Furthermore, low-interest products, such as refrigerators, have different lifecycles than high-interest products, such as laptops and mobile phones. Hence, different approaches are required in the business models of firms that product low-interest and high-interest goods (Bakker et al., 2014).

**Figure 8. Homogenous Circularity**

**Figure 9. Heterogeneous Circularity**
Ownership-based Circularity

One of the well-known business model used in CEs is called “product as service,” in which circularity exists between the focal firm and the customer. In this ownership-based circularity, the relationship between the firm and the customer completely changes from a seller–buyer to a lender–borrower relationship. The concept has been a popular research subject since the mid-1990s, and it has been dealt with in different terms such as “servitization,” “service-oriented business model,” and the recent norm, “product service system,” or “PSS” (Tukker, 2015). One definition of PSS is “a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs” (Tukker & Tischner, 2006).

The two most distinguished characteristics of PSS is the ownership of the product and the range of responsibility of the producer. Unlike traditional consumption, in which users pay for the product and retain ownership of said product, in PSS, producers retain the ownership of the product and provide services using the product. From the customer point of view, their needs are fulfilled without the need to own the product. For instance, instead of purchasing light bulbs, customers pay for the time for which they use lighting. Producers take the product back when it is damaged or at the end of its lifecycle so that it can be recycled or refurbished.

Secondly, the producer remains responsible throughout the use, maintenance, repair, disposal, and recycling process (Schwager & Moser, 2006). Compared to the traditional way, in which the responsibility of the producer ends at the point of sale, in PSS, the producer is in charge of the performance of the product until the end of its lifetime, and even afterwards. This resolves the problem of the maximum value of the product not being fully exhausted by users due to the information and knowledge asymmetry between producers and users. Furthermore, the data obtained from a service regarding the usage of a product can be valuable input for the improvement of the product.
Providing products as services is an alternative way of making a profit in which firms have reduced incentives to sell many products, which leads to decreased production (Tukker, 2015). Another factor of PSS that leads to the reduced consumption of resources is that by offering services, firms can accurately predict demand. This prevents over-production and improves stock management. To minimize the cost of a service, the products will be designed in cost-efficient and material-efficient ways. Furthermore, one of the indirect advantages of PSS is that it is a good method of differentiation in a competitive market; one of the goals of PSS is to enhance competitiveness (Wang et al., 2011).

Literature shows that multiple barriers to PSS have been identified in several industries. In the automotive industry, PSS requires significant changes in ownership structure, infrastructure, and institutional context (Williams, 2007). In the home/office electronic industry, consumers prefer to buy new products after only a few years of use, and ownership is linked to low system costs due to the more careful use of owned products than rented ones (Intlekofer et al., 2010; Kuo, 2011). While consumers value ownership and having control over products, business customers do not have the same values (Tukker, 2015). Another significant barrier is the high labor intensity. PSS requires staff who possess both product knowledge and management skills. Therefore, it can be more expensive than having a product operated by a consumer (Tukker, 2015).

2.4. Business Modelling Tools and Frameworks

In this research, framework is a term used to describe a conceptual paradigm and a tool is an implement used to carry out particular functions or accomplish specific tasks (Hristozov et al., 2016). A tool is also called ontology which is defined as an explicit specification of a conceptualization (Osterwalder, 2004). Although a framework and a tool are two different concepts, there is a large overlap and close interaction between them. Some tools are developed based on frameworks, and some frameworks are derived from existing tools.

2.4.1 Tool: Business Model Canvas

The business model canvas is a tool that is frequently used by firms in various stages of their business models from generation to evaluation. Osterwalder (2010) created the business model canvas as a tool for describing, analyzing, and designing business models. It describes the logic of how firms generate profit and helps with the structuring of firms as well as the development of strategies in simple and easy manners. Figure 11 shows the nine building blocks that present the comprehensive view of a firm’s activities throughout the entire process and the values carried with
the flow. The components on the left side, partners, activities, and resources, show how firms create value, and the components on the right side, customer relationships, channels, and customer segments, refer to how firms deliver value. The components on the bottom, cost and revenues, refer to how firms capture value. The canvas also exhibits the efficiency-driven components on the left side and the value-driven components on the right side (Osterwalder, 2010).

![Business Model Canvas](Image)

**Figure 11. Business Model Canvas (Osterwalder, 2010)**

Business model canvas became most dominant tool by its simplicity and easiness to use while providing a clear overview of a business model. Despite such advantages, the tool was limited to the elements that are directly contributing to profit maximization. The tool is not suitable for other values to be part of consideration or have a significant impact.

2.4.2. Tool: Business Model Stress Testing

While business model canvas provides a selected set of key components, the business model stress testing allows users to select few factors that are critical to their business model. This tool makes use of existing ontologies as it can be applied to any structured BM description. Haaker et al. (2017) suggest the use of business model stress testing as a tool with which to increase the robustness of business models, which they define as the long-term viability and feasibility of a business model. The test involves the application of scenario planning to anticipate feasible outcomes caused by external factors, such as trends and uncertainties. Some of the factors that have critical impacts on a BM will be identified as stress factors and be visualized in a heat map.
BM stress testing is suitable for the experimental stage of BM, especially considering unexpected factors. It can be useful for industries that are sensitive to external factors and require agile decision making.

However, this tool is not a standalone tool and requires few external ontologies such as business model canvas or PESTEL analysis (political, economic, social, technological, legal, and environmental factors) to complete the testing. Although this tool is ontology-agnostic, adding more ontology increases overall complexity. Furthermore, the result of the analysis is dependent on the few selected stress factors, and the remaining factors are neglected.

2.4.3. Framework: The four value dimensions of business models

The framework of Al-Debei and Fitzgerald (2010) presents the four construct of business model; value preposition, value architecture, value network and value finance to explain the primary constructs and dimensions of the BM concept.

Figure 12. Six-step approach for business model stress testing (Haaker et al., 2017)
Compared to the above-mentioned business model canvas, the most remarkable difference is the value network that stresses the importance of the cooperation within a network. The multi-party stakeholder network ranges from cross-company to inter-organizational cooperation. It provides a clear view of the roles of different actors and explicitly shows how the value is exchanged among stakeholders (Al-Debei & Fitzgerald, 2010).

2.5. Business Modelling Tools and Frameworks for Sustainable Business Models

The appearance of sustainable business models encouraged more corporations to include sustainable values in their business agenda putting equal or more weigh on sustainability as profit. The two values are not contradicting but could lead to opposite decisions. Therefore, the previous business modelling tools were required to change in order to represent different voices. The tools for sustainable business models try to balance the interest of different stakeholders.

2.5.1. Tool: Triple Layered Business Model Canvas

Joyce and Paquin (2016) created the triple layered business model canvas (TLBMC) by adding the environmental and social layers to the original BMC for sustainable business models. The TLBMC can be found in the Appendix. The three layers of the TLBMC, economic, environmental, and social layers, are based on the triple bottom line approach, which was established by John Elkington in the mid-1990s, seeking values beyond the traditional goals of firms, such as increased profit, which is measured by returns on investment (Slaper & Hall, 2011). The triple bottom line approach is used to measure the economic, environmental, and social impacts of an organization's activities and has
been widely adopted by organizations to achieve sustainability goals (Savitz, 2012). Based on this approach, the TLBMC explicitly addresses economic, environmental, and social value creation as core to an organization’s business model, and it is a practical tool with which to integrate economic, environmental, and social concerns into a holistic view of an organization’s business model (Joyce & Paquin, 2016).

![Figure 14. Triple Layered Business Model Canvas (Joyce & Paquin, 2016)](image)

The environmental layer of TLBMC stems from the research and practice of lifecycle assessments (LCA) and visualizations of the environmental impacts over the full lifecycle of a product or service (Joyce & Paquin, 2016). The nine components that originated from the BMC are suppliers and outsourcing, production, functional value, lifecycle, user phase, materials, distribution, environmental impacts, and environmental benefits.

The social layer of the TLBMC builds on a stakeholder management perspective by seeking the balanced interest of an organization’s stakeholders, instead of maximizing the profit of the organization itself. The components of the original social layer of the canvas are social value, employees, governance, communities, societal culture, scale of outreach, end users, social impacts, and social benefits.

Although this tool seems to be useful for CBMs, the social aspect of CBMs has not been discovered much, unlike SBMs. Therefore, this paper made some adjustment in the social layer of the tool focusing on the stakeholder relations and tested it with the case of DESSO. DESSO recycles used carpet and make it into a new carpet. See appendix C for the test result.

2.5.2. Tool: Value Mapping

Bocken et al. (2013) proposes the use of the value mapping tool to assist companies with the development of a business model that has embedded sustainable values. Companies can use this tool to create sustainable business models that reach beyond the economic values for the interest of broader stakeholders. The tool suggests three forms of values that are currently captured, missed,
destroyed, or created. The three forms of values are looked into the perspective of four groups of stakeholders: the environment, society, customers, and network actors.

Figure 15. Simplified value mapping tool (Bocken et al., 2013)

Compared to existing business model tools, such as the business model canvas, the value mapping tool provides more balanced views of different stakeholders as well as a clearer division of target values to tackle. However, the tool has limitations when applied to CBMs. The impacts on society are limited, and it has interrelations and dependencies on network actors and customers.

2.5.3. Conceptual Sustainable Business Model Framework

Bocken et al. (2015) presented the conceptual sustainable business model framework derived from the above-mentioned value mapping tool. It shows the interconnectedness among the three categories: value proposition, value creation, and value capture mechanism.
2.5.4. Framework for Sustainable Circular Business Model Innovation

Antikainen and Valkokari (2016) find that the current business modeling tools lack some important perspectives on business model innovation for CBMs. Therefore, they add important perspectives for CBMs, such as the trends and drivers at the ecosystem level, the value to partners and stakeholders within a business, and the impacts of sustainability and circularity. The framework suggests a continuous iteration of the evaluation of sustainability and circularity so that the process can be optimized and the dynamic of the process can be understood. In this way, the tool includes the important factors of business innovation in sustainability and CBMs. The framework is the most specified tool for CBMs among the existing business modeling tools. However, it requires further development because the current tool has vague descriptions and limited examples.

![Framework for Sustainable Circular Business Model Innovation](image)

2.6. Conclusion

The first half of the literature review about the core concepts of the implementation of CBMs confirms that the topic is still relatively new and a dominant definition does not exist. Each concept shows diverse paths of development and different perspectives and interpretations. Therefore, there is an opportunity for the researcher to promote wide acceptance and understanding.
The review of the business modelling tools for general and sustainable business models shows that the existing tools have a limitation regarding the elaboration on the circular values that CBMs have. Therefore, there is a need for a tool that includes circular values.

<table>
<thead>
<tr>
<th>Literature Review</th>
<th>Research Question</th>
<th>RQ1. What is the current state of CBM?</th>
<th>RQ2. What are the success factors and challenges in the implementation of CBMs by firms?</th>
<th>RQ3. To what extent do business modelling tools help with the implementation of CBMs by firms?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Circular Economy</td>
<td>- Definitions</td>
<td></td>
<td>- Critical elements</td>
<td>- Comprehensiveness</td>
</tr>
<tr>
<td>2.2. Business Model</td>
<td>- Developments</td>
<td></td>
<td>- Goals of CBM</td>
<td>- Guidance</td>
</tr>
<tr>
<td>2.3. Circular Business Models</td>
<td>- Classifications of CBMs</td>
<td></td>
<td></td>
<td>- Missing elements</td>
</tr>
<tr>
<td>2.4. Business Modelling Tools</td>
<td>- Surrounding environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5. Business Modelling Tools for sustainable Business Models</td>
<td>- Challenges</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 1. Relevance of the literature review to the research questions*

The relevance of the literature review to this research is as follows:

First of all, the literature review provides a theoretical background to the research by subdividing the main research topic into several core concepts and looking into them separately. Understanding circular economy, business model and circular business model contributes to the establishment of the foundation of the research and works as a starting point for the research.

Secondly, it defines the direction and scope of the research, indicates the focal research points and the core elements of this research. The literature review shows which parts of the topic have been well-discovered and which have not. This prevents a duplication of research and places the focus on an undiscovered area of the topic. Because a circular business model is a relatively novel topic, some gaps in research were found such as a social aspect of CBM. It also helps define the scope of the research and indicate what to include and exclude in the research.

Lastly, the literature contributes to the research design and development of the methodology that is used in this research. It gives an indication of how the research should be structured and what the most suitable methodology for the research is. Especially, the framework that is used in the
case study of this research is created based on the framework of four value dimensions of business models and the conceptual sustainable business model that have been reviewed in this chapter. Furthermore, it shows which data needs to be collected and the most effective way to obtain it.
3 Methodology

3.1. Research framework
3.2. Expert interview
3.3. Case study strategy
3.4. Data collection
The author of this paper tries to provide both theoretical and empirical knowledge about CBMs by exploring the literature and some ongoing cases. The literature review is the foundation of the research and the theoretical basis of the accumulated knowledge. The expert interview helps to overcome the limitations of scientific research papers and connects theory and reality in a balanced way. The case study supplements the missing parts of theory and shows how the theory is applied in the real world. The collective methods provide comprehensive knowledge on CBMs and insight to help to do the following:

1. Understand the current state of CBMs
2. Find critical factors of CBMs
3. Make a tool to help companies make certain simple decisions

In this chapter, the framework of this research is explained and the sequence of the process and detailed activities in each step are described. The methodologies used in the research, expert interview and cast study, will be explained showing what those methods are and why it fits for the purpose of this research, and what is to be expected from using these methods. Lastly, the data collection design of each methodology will be explained in detail, including how the data was collected and treated after collection.

3.1. Research Framework

The research framework explains how the research develops and the approach to the conclusion in steps. Figure 18 shows an overview of the research flow. In the literature review, the four main concepts that are identified as critical to this research were reviewed in the existing literature.
3.2. Expert interview

The expert interview is one of the methods used in qualitative research that is usually used as a complementary method rather than a standalone method. It can also be used in the preparation of the main instrument in a study by collecting context information complementing insights from applying other methods (Bogner & Menz, 2002; Flick, 2009). In this research, the expert interview is used preliminary for the case study.

Experts can see the big picture in their knowledge field and have systematic and specific knowledge. The expert interviews have exploratory and inductive elements in a new field and help the researcher refine the preliminary model or structure by including new factors that are identified in the interviews (Bogner & Menz, 2002; Schlegel, 2015, Flick, 2009). A semi-structured interview is a systematic and comprehensive approach with which to ensure all key issues are explored and its flexibility allows for tailored interviews that explore individual perspectives and the experiences of the interviewee's specialized knowledge (Patton, 2002; Schlegel, 2015).

Schlegel (2015) suggests that consultants are ideal candidates for interviews. Consultants gain insights by working with or looking into a large number of companies in their specialized industry. Consultants have deep theoretical background in their fields and combined with their knowledge and experience, they can help identify differences and similarities between companies with different characteristics. Furthermore, their view is less biased because they are fewer influenced by the cultures and routines of an individual company.

Because CE is not a traditional concept, the knowledge of it has not been well-accumulated in academic research papers. Not only is the theoretical research on the concept is immature but also the empirical research that has been completed or is ongoing remains largely unknown. This can lead the research to have limited results. Interviewing experts enables the exploration of the latest information about CE that has not been published in academic papers. Furthermore, information that is not considered as a proper research data but is important can be earned through expert interviews.

The objectives of the expert interview in the research are
• to get a state of the art overview of CBMs in the Netherlands,
• to answer the research questions,
• to get a recommendation about companies for the case study,
• to identify the gap between the perspectives of experts and companies.
The difficulties of conducting expert interviews are identifying the expert who has the correct knowledge and deals with confidentiality. The interviewer has to be careful not to be distracted by unimportant issues that are found in the data (David and Sutton, 2011). This danger is minimized in this thesis because the researcher did not conduct rounds of data analysis after each individual interview. Instead, the data was only analyzed after several interviews had been conducted.

**Expert Interview Design**

The expert interview was conducted prior to the case study, partially as a form of preparation for the case study. The selection of experts is based on purposive sampling. For diversity purposes, the experts were selected from different organizations, positions, and backgrounds. The selected experts are currently active in academia, government organizations, consultancy firms, and foundations in the Netherlands. The experts were selected based on their current positions, which vary from researcher to head of organization, as well as the lengths of their careers in CE. A long list of the experts was made based on publications, media interviews, recommendations, LinkedIn, and the researcher’s personal network. The invitations to the interviews were sent via email and those who showed interest and had time were selected. Some of the experts were recommended by the initially contacted experts and added to the list.

The list of selected experts is as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Type of organization</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antonie Heideveld</td>
<td>Het Groene Brien</td>
<td>Scientific network</td>
<td>Director</td>
</tr>
<tr>
<td>Phil Brown</td>
<td>Delft University of Technology</td>
<td>Academia</td>
<td>PhD Researcher - Circular Product Design</td>
</tr>
<tr>
<td>Paul van Bergen</td>
<td>DGMR</td>
<td>Consultancy</td>
<td>Managing Director</td>
</tr>
<tr>
<td>Walter van den</td>
<td>Rijksdienst voor Ondernemend</td>
<td>Government</td>
<td>Senior advisor Circular Economy</td>
</tr>
<tr>
<td>Wittenboer</td>
<td>Nederland (RVO)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ben Kubbinga</td>
<td>Circular Economy</td>
<td>Social enterprise</td>
<td>Senior Project Manager</td>
</tr>
<tr>
<td>Bas Mentink</td>
<td>Royal Haskoning DHV</td>
<td>Consultancy</td>
<td>Consultant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sustainability</td>
</tr>
</tbody>
</table>

**Table 2. List of interviewees for expert interview**

The initial structure of the interview was a standardized interview where the same sequence and wording of questions are used in each interview (Schlegel, 2015). There were only open-ended questions. However, during the interview, the interviewer asked some follow-up questions when necessary. Therefore, the interviews were flexible semi-structured interviews. The experts received the same questionnaire prior to the interview, and the interviews lasted for one hour to two hours and were conducted in English.
3.3. Case Study Strategy

The case study is a useful method for understanding phenomena of interest and generating further knowledge in that area (Sekaran & Bougie, 2010). Studying multiple cases involves in-depth and contextual analyses of similar situations in different organizations and allows for a reasonable comparison. A case study is suitable for answering how and why questions that cannot be proven through experiments (Yin, 2013). Picking the correct cases for study and getting access to the right data is critical for successful analysis. Usually, companies are sensitive about sharing their internal data with external parties. Therefore, trust between researcher and the sensible treatment of data is required (Sekaran & Bougie, 2010).

By analyzing the results of the case study, the researcher expects to identify the gap between a theory and the implementation of that theory in an actual case by discovering factors that are difficult to predict, such as human error, irrational or illogical decisions or actions, or industry specific customs. The factors that have not received attention in academia, such as tacit information, can be discovered through a case study. Conducting a multi-case study and cross-case study will increase the validity of research compared to a single-case study. Furthermore, cross-case study prevents researchers from reaching premature or false conclusions that can result from bias while processing information (Eisenhardt, 1989).

Case Selection

The pool of the cases provides examples of the CE100, C-Plan, The Netherlands Circular Hotspot, and few suggestions from the experts during the interview. The selection criteria are the following:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Details</th>
<th>Criteria</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Type of CBM</td>
<td>Resource-based</td>
<td>5. Maturity</td>
<td>Existing customers</td>
</tr>
<tr>
<td>2. Size of waste</td>
<td>Bulk waste</td>
<td>6. Location</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>4. Novelty</td>
<td>Less exposed firms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 3. The criteria for case selection*

The first three criteria are related to the effectiveness of business models. Firstly, compared to other types of CBMs, resource-based CBMs have higher feasibility because they can be implemented without involving a systematic or behavioral change that would require long-term planning. Furthermore, manufacturing firms in material-intensive industries find resource-based CBMs attractive because they can benefit from reducing virgin material use. Secondly, cases of bulk waste
were selected. Waste should contain enough material to recover especially, considering the loss of material in the recovery process. The impact on the amount of waste saved from landfill or incineration is also greater for bulky waste than other waste. Thirdly, companies in the B2B market were selected due to the ease of the collection of waste, which makes the CBM more effective.

Some overly-studied cases were eliminated from the selection, even though they met the inclusion criteria. Exploring underexposed cases adds value to the research in terms of novelty. Some firms who are in the stage of testing or only have prototypes were eliminated from the selection. Therefore, only firms that already had customers were selected. Sixthly, to eliminate country-specific variables, all selected cases were from the same country, in this case, the Netherlands. Lastly, the cases that are based on recycling technology are selected as this research is conducted as part of the education of Management of Technology.

Additionally, some minor criteria have been applied. Some industries were excluded from the selection because of their short product lifecycles, such as in the food industry. Moreover, if the firm’s business model simply provides a platform to facilitate recycling, such as exchanging clothes between users or mediating the sales of secondhand equipment, then those firms were also excluded.

<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>StoneCyling</td>
<td>Making bricks with waste from the ceramics, glass and insulation industries, and rejected clay from traditional brick manufacturing</td>
</tr>
<tr>
<td>Verimpex</td>
<td>Airplane tire to doormat</td>
</tr>
<tr>
<td>Inashco</td>
<td>Waste-to-energy from ash</td>
</tr>
<tr>
<td>Philips Lighting</td>
<td>Lighting as service</td>
</tr>
<tr>
<td>Bundles</td>
<td>Laundry machine with pay-per-use model</td>
</tr>
<tr>
<td>Desso</td>
<td>Cradle to Cradle Carpet Company</td>
</tr>
<tr>
<td>Interface</td>
<td>Sustainable Carpet Company</td>
</tr>
<tr>
<td>AELS</td>
<td>Aircraft End-of-Life Solutions</td>
</tr>
<tr>
<td>Refil</td>
<td>Recycled filament for 3D printers</td>
</tr>
</tbody>
</table>

*Table 4. Longlist of case study candidates*

The cases were selected from different industries and types of company to look into diverse CBMs. Moreover, it is difficult to find one industry in which multiple firms with different CBMs are active because the concept is still relatively new. The business model of Black Bear Carbon (BBC) completes a closed-loop by obtaining carbon black from used tires and supplying it for new tire production.
The value network of BBC shows a clear material flow among the actors in the network. In the case of DSM NIAGA, its business model and value network enable the production of 100% recyclable carpets, which closes the material loop. The business model of Van Houtum allows its customers to circulate the waste paper that is collected from them back to them in the form of toilet paper. Detailed introductions to each company are provided in Chapter 4.

<table>
<thead>
<tr>
<th>Company</th>
<th>Black Bear Carbon</th>
<th>DSM NIAGA</th>
<th>Van Houtum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste</td>
<td>Tire</td>
<td>Carpet</td>
<td>Paper</td>
</tr>
<tr>
<td>Product</td>
<td>Carbon Black</td>
<td>Carpet machine and adhesive</td>
<td>Toilet paper</td>
</tr>
<tr>
<td>Type of company</td>
<td>Startup</td>
<td>Joint venture</td>
<td>Incumbent</td>
</tr>
<tr>
<td>Scope of CBM</td>
<td>Entire company</td>
<td>Entire company</td>
<td>Certain product</td>
</tr>
</tbody>
</table>

*Table 5. A brief description of selected cases*

The unit of analysis is a business model of a product/service. Even though a firm offers several applications using the same material, the components of the business model of each application are different, therefore, each product/service line should be analyzed separately. Furthermore, many companies have circular and linear processes coexisting in their portfolio. To have more accurate analysis in CBMs, a product/service line will be selected from each company.

### 3.4. Case study framework

To gain a deep understanding of CBMs, this study used a framework that was adapted from two business model frameworks: the four value dimensions of business models by Al-Debei and Fitzgerald (2010) and the conceptual sustainable business model framework by Bocken et al. (2015).

Details of the two frameworks can be found in the literature review, the second chapter of this paper. The proposed framework for this case study provides a holistic view of CBMs by complementing the two existing frameworks. Bocken et al.’s framework was designed for sustainable businesses. Therefore, it supplements the narrow focus of the framework of Al-Debei and Fitzgerald. On the contrary, Al-Debei and Fitzgerald’s framework supplements the missing pillar of the network and better visualizes how the value is shared in the network, which is not clearly visible in the framework of Bocken et al.
Circular Value
The existence of circular value in business distinguishes CBMs from other business models. The circular value that is generated from end-of-use products often reaches beyond firm’s customers toward society or the world because it is closely connected to environmental impacts. The circular value is created when firms consider the goals of their CBMs prior to other values, such as profit.

A. Value Network
The value network describes the interaction between the actors in the network who contribute to creating the circular value. Because circular value cannot be created by a single firm, approaching it from a network level instead of a firm level and following the flow is critical to understanding the entire impact. Therefore, identifying the network components and visualizing the network helps with the understanding of circular values.

The main actors in the value network play essential roles in the creation of circular value. In general, the key roles are played by suppliers, manufacturers, collectors, partners, and customers. However, it is possible for one actor to play multiple roles. Once the actors and their roles are identified, the relationship with the focal firm can be discovered. It shows what kind of partnership they have and their characteristics, such as exclusivity, interdependency, or irreplaceability.
The value flow visualizes the flow of the core material in the network. The flow of the material shows how the value increases and decreases from one actor to another. Following the flow in the map will enable the clarification of the interests of each actor to help identify possible conflicting values or interests with the focal firm.

B. Value Proposition
Circular value is provided in the form of products or services. In normal BMs, a value proposition is strictly focused on the customer who pays for the product or service. In CBMs, however, the beneficiaries of products reach beyond the customer who pays for the product. Even though the products or services of a circular business are similar or the same as those of linear businesses, the value elements and target segments can be different.

Value is provided to customers through products and services. Firms choose forms that deliver value to their customers. The value element describes what values are incorporated within the product or service the firm is offering. The value can be for paying customers, the environment, or society. The product or service and value elements are used to determine the target segment in which the benefits can be maximized.

C. Value architecture
The value architecture component shows how value is provided by discovering what a firm possesses, what the firm does with its possessions, the strengths of the firm, how the structure of the firm is organized internally, and lastly, which external legislation applies to the products or services of the firm. The key of this component is to determine how the architecture is different from linear business models. What is additionally required or no longer required becomes more or less important in CBMs compared to linear business models, and what is the core activity of a circular firm if it is different from linear firms.

D. Value finance
The value finance component involves determining how firms capture monetary value and how and where financial resources are spent and gained. In circular value financing, the clear difference between CBMs and LBMs are highlighted. Cost and revenue describe where the major costs occur and how the major revenue is generated. It will allow where the difference occurs compared to the linear business models. Indirect monetary value, such as tax reductions can also be shown in this category. The pricing method will also show how circular business affects pricing policy and revenue compared to linear business.
3.5. Data collection strategy

Desk Research
Desk research was conducted to gain a basic understanding of the selected companies, including company type, size, history, product or services, partners and customers, and business model, by gathering information that was available online. The sources of desk research were company websites, publications, media coverage conference presentations, videos, and written interviews with free access. In parallel to the desk research, the interview questions and the framework of the case study were developed based on the results of the desk research through an iterative process of modification.

Interview
The purpose of the interviews is twofold: to get access to internal information and to review the results of the desk research. First of all, the information that is available online provides a basic understanding of the company. However, it does not always provide detailed or complicated information, such as the motivation behind their business models, the names of suppliers, or the relationship with each partner. The information that is necessary for this research is not classified information. It is unrevealed because it is not necessary or interesting for the public. Secondly, the result of the desk research was reviewed during interviews to verify the information that was collected from various sources. The missing information was filled in and misinterpreted information was corrected during the interviews.

The semi-structured interviews were scheduled for 45 to 60 minutes. However, they lasted longer than the planned time in all cases. In the case of BBC, an unstructured pre-interview was conducted to gain a general overview of the company and its business model. The result of this pre-interview is reflected in the design of the case study and the formulation of the interview questionnaire.

<table>
<thead>
<tr>
<th>Company</th>
<th>Position</th>
<th>Date</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Bear Carbon</td>
<td>Finance and Business Development Manager</td>
<td>15 June, 2017</td>
<td>60 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 July, 2017</td>
<td>75 min</td>
</tr>
<tr>
<td>DSM NIAGA</td>
<td>Marketing Manager</td>
<td>18 July, 2017</td>
<td>80 min</td>
</tr>
<tr>
<td>Van Houtum</td>
<td>Innovation and Business Intelligence Manager</td>
<td>24 July, 2017</td>
<td>70 min</td>
</tr>
</tbody>
</table>

*Table 6. List of interviewees for case study*
The preparation of interviewees affected the quality of interviews because the answers were clear, straightforward, and within the scope of the research question. After the interview, a follow-up email was sent to the interviewees to ask additional questions or for additional information or to clarify some parts that were not clearly answered during the interview. However, not all emails were answered. The interview questionnaire was generated along with the above-mentioned case study framework and can be found in the Appendix.

Result of the case study
The data gathered from the three cases was analyzed in two ways. First, the data from each case was analyzed separately based on the case study framework, which is elaborated on in the following chapter. This process provides an understanding of the business model of each company and covers the specific issues of each case. Subsequently, the data gathered from each case was compared to identify the similarities and differences among the cases. The analysis of the cases directly answers the second sub-research question What are the success factors and challenges in the implementation of CBM by firms? and provide a base for the third research question What recommendations can be made for the development of business modelling tools for CBM?
4

Multi-case Analysis

4.1. Result of expert interview
4.2. Black Bear Carbon
4.3. DSM NIAGA
4.4. Van Houtum
4.1. Result of The Expert Interview

The expert interview has been conducted to obtain the insight of from the professionals who are closely involved in the activities related to circular business models. The experts do not belong to a single firm that has implemented circular business model; however, they are either working for such firms or working closely with circular firms. Therefore, their experiences are not limited to a particular firm. The interview is based on their knowledge and experiences showing the diverse views from experts in the government, consultancy firm, university and scientific network. The questions are subdivided into the important elements of circular business models.

Current State of Circular Business Models

Circular Business Model
There is no clear and concrete definition of CBM that is dominantly used in academia, government, or industry. The widely known definitions are the ones proposed by the Ellen Macarthur Foundation and Accenture. The current vague understanding of the concept allows for diverse circular approaches to be taken by companies. Companies take this as an opportunity to include the concept of circularity in their business agendas based on their own interpretations. It has had positive and negative impacts on the circular business industry because it lowered the entry barrier and made some room for new concepts. On the contrary, the broad concept has created confusion and made it difficult for parties who require a clear definition, such as law enforcement.

Difference between Circular Business Model and Sustainable Business Model
The understandings of the relationship between CBM and SBM are mixed. Firstly, the majority agrees that SBM and CBM are similar with large areas of overlap with each other but different focuses. This view is based on the triple bottom line approach. The main focus of the SBM is environmental and social aspects while the CBM focuses on environmental and economic aspects. Therefore, there is some room for improvement to the CBM in the aspect of social impacts. Because the two concepts complement each other, a holistic view that integrates both concepts can generate synergy and ensure the fulfillment of the three pillars.

Compared to the SBM, the CBM is considered to be more network-oriented and risky. Because a CBM requires the use of waste as a main resource, securing and processing waste is the core of the business that can be accomplished through collaboration with partners in the value network. Given the emphasis on close collaboration, aligned interests and trust between actors in the network are essential. Furthermore, the geographical scope of a CBM is narrower than that of an SBM because waste is collected locally.
Another perspective on the relationship between SBMs and CBMs is viewing CBMs as a sub-set of SBMs. This implies that CBMs are sustainable by nature. Opposite to this view, some scholars hold that SBMs and CBMs are different than each other. While the two concepts have some overlaps, such as contributing to nature by reducing waste, the energy consumption in such processes can be high when recovering materials from waste because doing so is very energy intensive. SBMs and CBMs do not necessarily contradict each other. However, this view acknowledges that sustainability is not a prerequisite for circularity.

**Motivation**

Going through the difficulties securing resources and dealing with the fluctuations of raw material prices, firms search for alternative resource supplies. Using waste to replace raw material is a strong motivation for companies to manage their sourcing problems in effective ways without investing in the development of new materials.

Secondly, companies try to differentiate themselves from their competitors and stand out in the market to survive. By adopting CBMs, firms can effectively market material toward customers to get their attention. Furthermore, firms expect the future market to be more circular than it is today. Therefore, to survive in the current and future markets, adopting a CBM is no longer a choice.

The third motivation is meeting customer needs because customers seek sustainable value and want to project such value through the products they consume. This demand makes firms increasingly sustainable and circular. Particularly when a powerful and influential customer, such as a government, pursues circular value, there are strong impacts on the market and substantial changes.

The fourth motivation is the pursuit of profit. To increase revenue, firms continuously seek ways to reduce costs and increase the values of their products. The use of CBMs can help firms reduce the costs of raw materials. ‘Green’ premiums are not seen much in CBMs because the strength of a CBM is competitive pricing.

Lastly, some firms pursue CBMs as a way of fulfilling their responsibilities as manufacturers. Currently, the responsibilities of manufacturers only extend to the end of the life of the product. Firms with CBMs, however, extend their responsibilities to after their products’ lifespans to ensure that negative environmental impacts are minimized. In this way, the entire lifecycle of the products falls under the responsibility of the manufacturer.
An additional motivation that has not been identified is a governmental pull or push. A subsidy program for the firms who implement CBMs, regulations on the use of raw materials, and the encouragement of research activities on reducing raw material use can be a strong motivation for firms.

![Figure 20. Motivation and goal of CBM](image)

**Goal**

Firms adopt CBMs to achieve their internal and external goals. The primary goal that firms aim to tackle is resource scarcity and improving recycling efficiency so they recover high value from waste. The current recycling process still remains at a low level. The value added in the production process is mostly destroyed in the recovery process. The most common type of recycling is waste-to-energy recycling, which is achieved by burning waste. Companies aim to achieve high levels of recycling through waste to material recovery, and in this way, the value of an end-of-life product is passed on to a product again.

The second goal is the internal goal for firms to gain competitive advantages from CBMs that enable the firm to become increasingly profitable and prosperous in the market. By achieving this goal, firms strengthen their positions in the market and avoid the risk of being eliminated from the market. Furthermore, firm’s current activities contribute to reducing the prices of circular products. Therefore, in the future, circular products will have advantages. When the CE is mature, doing business with CBMs is expected to be more profitable than linear businesses.
Another internal goal is to realize the sustainability of the firm. A firm’s sustainability goal is normally above the minimum requirements of laws and regulations, and it aligns with the firm’s corporate values. The ambition is expressed in the measure of CO₂ emissions or the amount of saved waste that was to be buried or incinerated. Furthermore, it can also be an external goal when the firm is fulfilling the ambition of their customers or country through their CBM activities. By consuming the products from circular firms, both business customers and consumers participate in sustainable activities. The circular firm activity also contributes to the regional, national, and global sustainability movement.

**Sectors**

Although there is no specific sector in which CBM is most actively implemented, many cases of traditional material recycling have been observed. Even though the level of recycling efficiency is low, the knowledge of recycling has been accumulated and continuous attempts to improve efficiency and add value have been made over time. Therefore, instead of starting from a scratch, the knowledge is built up on the existing knowledge base. Understanding the characteristics of materials, related regulations, involved parties, market information, price information, and trends can be the basis of a CBM. Furthermore, the existence of recycling networks provides a sound foundation and system for CBMs. In the product as service business model, it has been found more often in a long-lasting high-value product than a short-lived low-value product.

*Critical factors in circular business model*

**Success Factors**

The most frequently mentioned success factor by experts is collaboration with stakeholders in the network. Because diverse actors are involved in the network, cross-sectional cooperation is inevitable. Therefore, understanding different business cultures and practices and the various interests of other actors is critical. In the planning stage, the benefits of all actors should be clearly identified and considered to guarantee the success of the network as a whole. By collaborating and helping with the success of the network, their relationship is strengthened, and a win-win-win situation becomes realizable.

The powerful clients who acknowledge the importance of value that circular business brings and have enough purchasing power are necessary to the successful implementation of a CBM. Without the strong influence of powerful customers, such as governments or large corporations, especially at the early stage, it is difficult for firms to attract smaller customers. This influence also plays a role in making the business environment favorable to circular companies.
Long-term planning is important, especially in industries in which products have long lifespans, such as the building industry. Particularly with the PSS business model, the period over which firms completely recover their costs is much longer compared to when they sell the product. Furthermore, it takes considerable time for the network, market, and users to change their behaviors and adapt to the new system.

In the case of switching from linear business to circular business or running both types in parallel in one firm, a strong involvement of management is required to provide a clear vision and goal. The quality of circular products is expected to be as good as existing products from linear processes. Therefore, meeting technological requirements and not compromising quality are keys to success.

**Challenges**

Some experts point out that environmental costs are not included in the current prices of linear products. Therefore, they are cheaper than circular products, which include recycling costs. While the prices of recycled materials are stable, the prices of raw materials, such as oil, can drop. This makes the use of raw materials very attractive to manufactures. As long as the prices of linear materials that are made with raw material remain lower than those of circular products, the transition to a CE will be discouraged or delayed.

The low prices of linear products also affect customer behavior. Even though circular products are available, have extended lives, and can be recycled, simply because it is cheaper to buy a new one, customers will not make use of the benefits of circular products. The time and effort to be spent on recycling or repairing products should be accepted by customers as well. The value that customers pursue and their behaviors can also be barriers for circular firms.

Circular companies experience difficulties with the existing waste-related legislation that was enacted based on the linear economy. Even though the benefits of circular products are greater than those of circular products regarding environmental impact, sometimes, the market entrance of such products is hindered by non-existing legislation or regulations that do not fit with the circular concept. The current definition of waste restricts waste from being upcycled as a new material.

Policy can also hinder firms from engaging in circular business. In the Netherlands, a subsidy for activities that convert waste to energy exists. However, waste to material conversion activities are not subsidized, despite the high efficiency of the recovery of value from waste. In the incineration
process, the materials and labor invested in the production phase are destroyed and generate negative environmental impacts.

In financial terms, the value of waste was considered to zero or even negative because of the costs involved in a disposal. Therefore, there is no method or tool with which to measure the residual value of different types of waste. This gap in the view of the value of end-of-life products is a barrier for circular firms when dealing with the financial sector. Furthermore, the introduction of PSS prolongs the return period of initial investment costs because the customers pay smaller usage or subscription fees during the period of usage instead of paying at the moment of purchase. The uncertainty about the quality of their products made of waste materials also makes it difficult for circular firms to deal with the financial sector.

**Perceptions of Stakeholders**

From a business customer’s perspective, the PSS model has positive financial value because costs shift from purchasing costs to operating cost. Furthermore, it becomes easy for customers to change service providers because they do not purchase the product and can simply switch providers.

Recyclers find the emergence of the CE to be an opportunity that will increase the value of waste. Discovering ways to cooperate with circular companies can diversify their business models. On the contrary, raw material suppliers find that the CE is a threat that may decrease in sales or raw materials. However, because the current consumption of a finite amount of raw materials will be discontinued at a certain point, it is inevitable that firms will need to change their current business strategies. Raw material suppliers can take CE as a chance to seek change for the future.

**Business Modeling Tool**

There is no dominant business modeling tool that is specifically helpful for CBMs, even though there is much ongoing research on the topic. Firms structure their business models by iterative testing and fine-tuning. The business model canvas is commonly used in industries. However, it does not show the interaction between actors in the network, which is a critical factor in CBMs. A cradle-to-cradle certificate can be used for the formation of a circular concept in business models.

**Future of circular business model**

Experts expect the CE to be more developed in the future than it is now. The norm in every industry will be to use recycled materials. A firm’s manufacturing activity will be at least net natural in terms of environmental impact in the future. The current niche level of CE will become a regime in the future following the transition theory. The term “circular economy” might disappear as it becomes
a regular practice. The Dutch government aims to achieve a 50% reduction in the use of primary raw materials from minerals, fossil fuels, and metals by 2030 (MINEZ & MINIM, 2016). Legislation will be CE-centric and facilitate further development.

From the customer perspective, improved awareness of resource and waste issues will encourage customers to seek circular products actively participate in recycling. Increasing customer interest in the CE will create a balance of power between manufacturers and customers.

One remarkable change that is foreseen is the advent of decentralized and localized economies. The current economic system is where production is centralized in certain industrialized areas or countries, and where international sourcing is mainstream. In the future, when the CE is widely spread, the boundaries between economies will be reduced, and the transportation of waste will become feasible. Production will be localized from the locally-collected waste on the regional level. One of the advantages will be the ease of tracking the source of the material, which is difficult or impossible in a global sourcing context.

There are still some obstacles foreseen to have this future to arrive. Experts found that economic growth actually retreats the efforts in CE. When Europe was suffering from a low economic growth rate, there were many active discussions on recycling waste and reusing materials. However, as economic growth started to improve, the discussion discontinued as all firms tried to recover their businesses and benefit from the growth. Other urgent social and political issues, such as the Brexit and the migrant crisis, have also been identified as obstacles to the carrying forward of the CE.

Conclusion

While a large part of the expert interview accords with the findings of the literature, it also adds some new aspects to it such as the importance of the financial sector and the decentralization of the economy. The different functions and industrial backgrounds of the experts added diverse perspectives to the interview that resulted in showing some different views on a certain subject such as the differences between CBM and SBM. All the experts agreed on the bright vision of circular business models, although the achieving the circular economy will take a considerate amount of time. The result of the interview is used in the formulation of the framework of the case study and as a background information for the interviews for the case study.
4.2. Black Bear Carbon

4.2.1. Introduction

Black Bear Carbon (BBC) is a Dutch start-up that upcycles carbon black from end-of-life tires (ELT). BBC’s carbon black grades are able to address various industries such as the tire, technical rubber, plastics, inks and coatings industries. Through its pyrolysis process, BBC closes the material loop of tire production; therefore, this research focuses on the loop of tire production only. BBC provides high quality carbon black as the quality is critical in terms of performance in the tire and rubber industry and as a tint / pigment in the plastics, inks and coatings industries. BBC considers itself a circular company rather than a company with a circular business model because the by-products of the black carbon manufacturing process such oil and gas go back into its process as an energy source.

BBC was established in 2010 whilst its founders sought methods to tackle ELTs. Having realized the seriousness of waste tire issue and the low efficiency of the traditional recycling method motivated the company to find a sustainable and financially attractive way to upcycle waste tires. After four years of R&D, the company was ready for the commercialization at the end of 2014. Since then, more than 75 customers have been testing their product. Currently, BBC has 16 employees and its first plant is located in Nederwerrt the Netherlands.

Current State

Every year, 13.5 million tons of ELTs are generated from more than 1.5 billion ELTs that are removed from vehicles. More than 50% of the ELTs are burned or land-filled, often in countries with a lose environmental control. In order to meet the demand of new tires which is 2.4 billion tires each year, approx. 5 million tons of virgin carbon black are produced from fossil fuels (Black Bear Carbon, 2017). BBC is not the first one to develop carbon black recovery technology, however, it is unique in the sense of focusing on providing a value proposition to carbon black users. In the past, oil recovery from ELTs was the prime interest of tire recycling, therefore, carbon black was considered a low-value by-product.

Future

BBC continues its R&D efforts to improve the quality of by-products, oil and gas, to be more circular and competitive in the market. As the primary interest of BBC is in the recovery of carbon black, the development of the by-products into higher value upcycled products require more time.
The company is trying to build an international network with large tire collectors in other countries to secure the supply of ELTs. Furthermore, the company is continuously looking for opportunities to expand the range of carbon black grades.

4.2.2. Results

Circular Business Model

The company finds circular economy as changing the traditional way of wasteful consumption by reusing or reducing the use of natural resources. In order to tackle resource scarcity and volatility in natural resource pricing, there is a strong drive to move towards a circular business model. In a circular business model, waste wouldn’t be simply recycled but high-value will be added to the waste. To convince consumers to reuse, the quality of the recycled product should maintain at least the same quality as the existing new product or better. The company aims to change the perception of the recycled products by showing customers that there is a technical value proposition on top of the “green” label, and at competitive market prices.

Circular Value

The primary goal that BBC aims to achieve via their CBM is, to tackle the waste tire problem and the pollution process of carbon black production. Every year, around 13.5 million tons of tires become waste, and more than half of them are burned or landfilled. The carbon black production process from virgin material requires 2 – 2.5 liters of crude oil to produce 1 kg of carbon black. In the current market, no other alternative way of producing carbon black without virgin material exists, except for the way BBC proposes, using ELTs.

![Flow diagram of the value network of Black Bear Carbon](image)

*Figure 21. Flow diagram of the value network of Black Bear Carbon*
**Value Network**

BBC formed a value network by involving one of the largest waste tire collectors and tire manufacturers. In the network of BBC, there are four main actors who are identified essential, including BBC itself.

Tire manufacturer – (6 out of top 10, names under Non-Disclosure Agreement)

In the circular network of BBC, tire manufacturers will purchase upcycled black carbon from BBC for the production of tires. The major tire manufacturers value BBC carbon black due to the technical values it offers and the manufacturers’ primary interest is to secure carbon black that meets the requirement of their specification coupled by the need to implement sustainable practices. To purchase the right carbon black grade, manufacturers undertake an extensive testing and approvals process. In case of the customers of BBC, the switching costs are high as tire manufacturers need to allocate the following resources: people, time, and the facilities. Therefore, switching to another grade and recycled carbon black is a lengthy technical process. BBC works closely with potential customers to identify the right application. BBC puts in a considerable effort and allocates R&D resources to better understand the product requirement and application for each customer. Lastly, the manufacturers are interested in reducing environmental impact and to pursue sustainable business. In general, major manufacturing firms try to find a way to produce their products in more sustainable ways by using sustainable materials or optimizing the process.

Black Bear Carbon - Supplier

Black Bear Carbon plays a role of a supplier providing carbon black to the tire manufacturer. BBC provides the sustainable solution to tire manufacturers that meets customer technical requirements. BBC brings not only circular value but also technical value to the network as carbon black is a highly technical product. The company finds the feedback from their partners very important as it is a source for improvement, innovation, and new business opportunity for the company.

Kargro B.V. - Tire Collectors

The collection system of ELTs is arranged by the Dutch tire manufacturers’ association. A tire collector or sometimes called recycler collects ELTs to recycle for a new purpose – in Europe, roughly half is used in energy recovery and the other half in material recovery. BBC partnered with the largest tire collector in the Netherlands, Kargro B.V, ensuring a stable supply of the tires and to provide tire recyclers with the opportunity to produce higher value products that are truly circular. Dutch Green Carbon was set up as the first Black Bear line to upcycle all the components of tires – carbon black, oil & gas (from rubber). The steel was already recycled by Kargro B.V.
<table>
<thead>
<tr>
<th>Supplier</th>
<th>Tire manufacturer</th>
<th>Tire collector</th>
<th>Vehicle user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor</td>
<td>Black Bear Carbon</td>
<td>Major companies e.g. 6 out of top ten tire manufacturers</td>
<td>Major collectors e.g. Kargro B.V</td>
</tr>
<tr>
<td>Function</td>
<td>Recover carbon black from used tire</td>
<td>Producing tires</td>
<td>Collecting ELTs</td>
</tr>
<tr>
<td>Role</td>
<td>Provide high-quality carbon black</td>
<td>Producing tires using recycled carbon black</td>
<td>Securing stable supply of ELTs</td>
</tr>
<tr>
<td>Action</td>
<td>Recover carbon black from used tire and remove toxic materials</td>
<td>Purchasing carbon black from BBC and produce tire with it</td>
<td>Collecting used tire and send it to Dutch Green Carbon, partnership with BBC</td>
</tr>
<tr>
<td>Interest</td>
<td>Supplying their carbon black to tire manufacturers, Improving production process</td>
<td>Making high-quality tires, low production cost, alternative material, less environmental impact</td>
<td>Higher value end product from ELTs</td>
</tr>
<tr>
<td>Relationship with BBC</td>
<td>Customer</td>
<td>Established joint-venture together</td>
<td>No direct relationship</td>
</tr>
</tbody>
</table>

Table 7. Actor analysis of Black Bear Carbon

Vehicle Users

The end users in the network are vehicle users who drive cars with tires which use carbon black as a reinforcing agent. The selection of a tire by end users are driven by the impact on fuel efficiency.

Besides the above-mentioned actors, the support of the Province of Limburg, the Dutch Government (subsidies) and European Commission (through subsidies, Eco-Innovation and Opzuid) have been instrumental in the development of Black Bear and Dutch Green Carbon. Furthermore, BBC finds the government to be important because some regulations can quickly push the market transition to a CE. On the contrary, some of the current waste regulations work as obstacles, such as the REACH regulation.

Value Proposition

The main product of concern to BBC is carbon black that is upcycled from ELTs. The BBC process allows for the production of carbon black grades that fulfill the requirements of each market segment such as tires, inks, rubber, plastic, and coatings. BBC targets major manufacturers these industries.
Value for customers

As the approval process of carbon black is a highly technical and lengthy process we provide customers with high level of service. Tire collectors are another type of customers to BBC and BBC provides solutions to the waste management issues that the collectors have.

Value for environment

Compared to the process of producing carbon black from virgin materials, the process of BBC makes more positive impacts on the environment. Each ton of carbon black produced by BBC is equivalent to a net positive benefit of 4.2 tons of CO\textsubscript{2} due to the avoidance of the use of oil to produce carbon black and from the generation green energy from the oil and gas by-products.

Value for society

Firstly, BBC carbon black is “clean”. The PAHs (polycyclic aromatic hydrocarbons) in the ELTs that came from the virgin carbon black is driven off in the BBC process. As PAHs are recognized as carcinogenic materials, the company provides a solution that allows for BBC carbon black grades to be used in skin-/food- contact products. Secondly, BBC creates jobs in rural areas. In general, the sites of tire collection are remote areas where not many jobs are available. By establishing a plant in these areas, BBC creates job opportunities in remote areas.

Value Architecture

Legislation

The fact that the product of BBC is new to the market and uses waste materials is both an obstacle and opportunity for the company in terms of regulations. Due to this fact, sometimes strict regulations are applied to BBC, allowing for some known products that are environmentally polluting to be easily placed in the market, whereas the product of BBC have fewer environmental impacts than others is hindered by some legislation because it is unknown to the relevant authorities. On the contrary, it could be a chance for BBC because the interests of regional, national, and European governments in material recovery is growing. The business of material recovery has advantages in obtaining relevant permits when establishing a business as well as obtaining subsidies.

Business Modelling Tools

BBC did not use any business modeling tools when generating its current business model. It started from the technology it retained and seek ways to bring value to the actors in the value chain. Only recently, the company used the business model canvas to have an overview of its aims, deliverables, and main driving factors. Because small factors keep changing, the tool is used to focus on the major elements. The firm found BMC simple to use and helps them focus on the main elements.
Value Finance

Main revenue is generated from the sales of carbon black and licensing technology.

Success factors

BBC finds that the most important success factor is product quality. Meeting the strict specifications of the tire manufacturing industry is critical to convincing customers to be interested in the product. The selection of carbon black affects the performance of tire and consequently, it affects the performance of a vehicle.

The second success factor is constant efforts to understand and meet customer needs beyond their requirements. Having the basic requirement fulfilled, BBC further engaged with its customers to improve the efficiency of the production process of customers.

Challenges

In the past, there have been several attempts to recycle ELTs. However, the focus of the recycling was to obtain oil and gas, leaving carbon black as a by-product of the recycling process. This coupled with the general public perception of “waste” provides challenges to enable customers to switch to BBC grades.

4.2.3. Summary

BBC provides circular and technical solutions to the customers by providing high-quality carbon black that is upcycled from ELTs by establishing close relationships with tire manufacturers by and tire collectors. Compared to the production process of carbon black from virgin material, each BBC line achieves net positive benefits in terms of CO₂ emission and eliminates toxic materials from the waste tires. Some legislations on waste hinders their business. However, some subsidies on waste help their business to improve. BBC used business model canvas to clarify the main element of their business model only after the business model was implemented. The company finds the quality of product and understanding customer needs as the most important success factors. BBC finds the negative perception of recycled materials and the traditional way of procurement as the biggest challenges to tackle.
4.3. DSM NIAGA

4.3.1. Introduction

DSM NIAGA is a joint venture between DSM, a global science-based company active in health, nutrition and materials, and Niaga, a Dutch tech-startup that provides sustainable materials solutions for the carpet industry. The company benefits from the advanced knowledge in the material science of DSM and operates like a startup making fast decisions. The company is established in 2014 and the first commercial-scale production facility was completed in October 2016. Since then, the company has had one customer at the moment. The company has 21 employees and is located in Zwolle, the Netherlands.

DSM NIAGA redesigns daily-used products to be fully recyclable. The key reasons making it possible are reducing the complexity of the material set, making different layers of materials that are easily separated after use and choosing the right materials that don’t degrade easily. The company chose carpets as their first product to tackle as carpets are used in every building, every day and have bulky size offering enough materials to recover. Carpet industry offers the company lots of opportunities, especially in convention centers where carpets should be changed weekly for a new trade show and on airplanes where carpets are replaced every 6-8 weeks.

Current State

In Europe, 37% of used carpets are burned, 60% ends up in landfills, and only 3% of carpets are recycled. There has been some effort put into solving the issue of waste carpet from few carpet manufactures. Companies such as Interface and Desso have developed carpet made of waste carpet. However, the technologies of the two companies have not reached 100% of recovery rate.

Technology

DSM NIAGA offers a set consisting of a machine, adhesive and the technology which enables the production of 100% recyclable carpets. The machine consists of two parts. Hoex (2017) explains that in the first part of the machine, fibers are fused in the primary backing as shown in figure 23. In the carpet production process, no water is required unlike any other carpet manufacturing process. In the second part of the machine, the primary backing is affixed to the secondary backing using the company’s special adhesive. This adhesive makes recycling process possible by simply separating the primary and secondary backing in the recovery process.
The existing carpets have been made with too many different materials which make recycling of the carpets is very difficult. The expertise of DSM in material science enabled the company to offer the market a way to produce 100% recyclable carpets which haven’t been possible in the market. The company plays a role of knowledge provider from the outside of the circle of carpet production and involves multiple actors in the value network which will be elaborated in the following chapters.
Future
DSM NIAGA liked to keep their future plan on their CBM confidential. Besides the CBM using carpet, the company is looking at other bulky waste materials such as furniture, mattress and building materials for its future business.

4.3.2. Results

Circular Business Model
DSM NIAGA finds the current one-time use of unreasonable in both economic and environmental perspective. The company tries to capitalize on the used carpet as every waste carpet has a certain amount of polyester which has a market price. Bulky material such as carpet has enough materials that the price of waste is high enough to cover the cost of the steps in the recycling process. Therefore, the company tries to influence the circle to make sure that the waste carpets are collected and circulates.

“Keep materials as long as possible in the economy for the highest possible value.”

Circular Value
Every year, 5.5 billion euros of virgin materials goes into carpets, and the entire amount can be saved if the materials are recycled. DSM NIAGA made this possible by developing a machine and adhesive that enable the production of mono-material carpets that can be 100% recycled. This brings the advantage of having a stable price for raw materials (used carpets) compared to the current situation in which the price of polyester fluctuates along with oil prices. DSM NIAGA aims to build an ecosystem in the carpet industry so that all the stakeholders can benefit from circular business operations. Because of the high material recovery rate, the saved virgin material can be used as a parameter to measure circularity of the business.
Value Network
The value flow of DSM NIAGA does not have the shape of a circle because the product of the company is equipment and knowledge, not the material that is circulated. Six actors are identified as important in the value network: the knowledge provider, machine manufacturers, carpet manufacturers, polyester upcyclers, carpet collectors, and carpet users.

DSM NIAGA - Knowledge Provider
In the value network, DSM NIAGA plays the role of a knowledge provider that brings technology, adhesives, and machines to the carpet market. Building on the basis of advanced knowledge on material science from DSM, the company has developed technology with which to produce carpet from mono-materials with reversible adhesive that can be easily separated from carpets after reaching the ends of their lives. Besides the adhesive, the simplification of material use is the key to recycling carpets because the current carpets consist of too many materials that are difficult to separate. The company co-developed the machine that enables the manufacturing of carpets with this reversible carpet together with LACOM, which is specialized in developing customized automated machines. The company sells the machine, adhesive, and technology as a package to carpet manufacturers. DSM NIAGA has licensed this package. The carpet manufacturers that use...
this technology pay license fees to DSM NIAGA based on the square meters of carpet they produce. The company does not earn profit from selling the machine. The company tries to penetrate the technology to more carpet manufacturers which ultimately contributes to reducing a significant amount of carpet waste.

Mohawk - Carpet Manufacturer
One of the actors who requires the biggest change to be part of the circular value network is the carpet manufacturer. Joining the network as a carpet manufacturer means purchasing a new machine from DSM NIAGA, using their adhesive and paying the license fee to the company. This could be perceived by the actor as losing autonomy or control of their business which has been a hindering factor for more manufacturers to become a customer of DSM NIAGA. For the same reason, the influence of DSM NIAGA as a knowledge provider. The company cannot decide on the possible implementation of subscription model which is feasible with the technology of the company.

Mohawk is the first flooring company to use the technology of DSM NIAGA. The company is using the machine and adhesive from DSM NIAGA to produce carpets and pays license fees to DSM NIAGA based on its production volume. Airo, the label Mohawk introduced by partnering up with DSM NIAGA, it reduced the install time by 25 percent and eliminated every material except for the recycled materials from used carpets.

LACOM - Machine manufacturer
LACOM is a German laminating and coating machine manufacturer that co-developed the carpet manufacturing machine with DSM NIAGA. The company is specialized in customizing automated machines and known to be highly innovative. This machine enables the production of carpet with mono-material with a reversible adhesive that is easily separated from a carpet.

CUMAPOL - Polyester Upcycler
CUMAPOL is specialized in polyester upgrading and in this network that they convert waste carpets to carpet fiber. The company doesn’t have a direct relationship with DSM NIAGA; however, the company tries to keep CUMAPOL in the network as it plays an important role in the circulation of used carpets.

Carpet Collectors
Carpet collectors do not have direct relationships with DSM NIAGA. However, the participation of carpet collectors is essential in completing the closed-loop. Therefore, DSM NIAGA tries to ensure that these companies remain in the network.
<table>
<thead>
<tr>
<th>Actor</th>
<th>Knowledge provider</th>
<th>Machine manufacturer</th>
<th>Carpet manufacturer</th>
<th>Polyester upcycler</th>
<th>Carpet collector</th>
<th>Carpet users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Developing ways to changing waste to material</td>
<td>Developing customized automated machine</td>
<td>Producing carpet</td>
<td>Upcycling waste to material</td>
<td>Collecting waste and send it to recyclers</td>
<td>Use carpet</td>
</tr>
<tr>
<td>Role</td>
<td>Providing technology and adhesive for recyclable carpet</td>
<td>Providing recyclable-carpet manufacturing machine</td>
<td>Producing recyclable-carpet</td>
<td>Providing recycled carpet fiber</td>
<td>Collect used carpet and send it to polyester recycler</td>
<td>Purchase carpet and use it</td>
</tr>
<tr>
<td>Action</td>
<td>Develop technology and adhesive</td>
<td>Develop carpet manufacturing machines</td>
<td>Purchase NIAGA machine and make reusable carpet</td>
<td>Make used carpet into carpet fiber</td>
<td>Collect used carpet and sell it to polyester recycler</td>
<td>Select and purchase carpet</td>
</tr>
<tr>
<td>Interest</td>
<td>More carpet manufacturers using their adhesive</td>
<td>More carpet manufacturers using their machines</td>
<td>Low production &amp; purchasing cost, making better carpet</td>
<td>Stable supply of waste carpets, Stable demand of recycled fiber</td>
<td>Higher waste value</td>
<td>Non-toxic, easy to clean carpet</td>
</tr>
<tr>
<td>Relationship with DSM NIAGA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8. Actor analysis of DSM NIAGA

End Users
The direct benefits end users, customers of Mohawk, receive from the carpet of DSM NIAGA is more health related such as non-toxic materials and easiness to clean. As the end-users don’t directly benefit from the carpet being recycled, such extra incentive is important.

Others
Incinerators are not favorable in this business model because they have to compete to secure used carpets because used carpets are good resources from which to generate energy.
**Value Proposition**

DSM NIAGA provides a set of technology, machines, and adhesive that enables carpet manufacturers to produce 100% recyclable carpets. The set is inseparable because the carpet machine only works with the reversible adhesive developed by DSM NIAGA.

**Value for customers**

Compared to the existing carpet manufacturing machines, the machines from DSM NIAGA are smaller, cheaper, and less energy- and water-consuming. This eliminates the benefit of aggregation, allowing for small-scale manufacturing at local hubs. This also reduces the issue of logistic and makes used and new carpets easy to transport. Eventually, this would reduce the radius of an area where carpets are produced, delivered, used, collected and recycled compared to the current global scale.

**Value for environment**

The carpets made from the technology of DSM are 100% fully recyclable. Therefore, this prevents carpets from ending up in landfills or incinerators. The process of producing carpets does not require water and uses 90% less energy than to the current mainstream lamination process. While an existing latex oven requires 260°C and 0.7 liters of water per square meter, the process of the DSM NIAGA machine requires room temperature and no water.

**Value for society**

DSM NIAGA can moderate a few health issues related to carpets. Indoor air quality can be improved because the end users can clean the carpet easily because the mono-material prevents deformation of the carpet due to washing. The carpet needs little glue because it does not have tension to roll and it does not give off gas. Therefore, no volatile organic compounds (VOCs) are released. Having a scattered manufacturing facilities that is mentioned in the value for customers, would create jobs in a region with smaller economy contributing to the balanced development between regions.

**Value Architecture**

**Legislation**

Some of the current legislation is not very favorable regarding waste recycling. However, the situation is slowly changing. Successful business cases will be recognized by the EU and will accelerate this change. However, the transition to a CE should be initiated on the industry side, not the government side. Even though the government tries to promote the concept by imposing
disadvantages on incineration or providing subsidies to circular businesses, the business feasibility is to be verified by the market.

Business Modelling Tool
The company used the business model canvas after making some adaptations by adding the residual value after the consumer phase. In this way, it becomes easy to spot opportunities to increase residual value.

Value Finance
Revenue
The primary source of revenue of DSM NIAGA comes from the sales of the package of technology, adhesive, and machine. It generates secondary revenue through licensing fees, which are generated based on the volumes of carpet companies produce using the machine of DSM NIAGA.

Cost
The carpet industry is a material-intensive industry for both in linear and circular businesses. Currently, 65% of the cost occurs in the purchase of carpet, which is relatively high compared to other industries. This is not the most attractive scenario for businesses.

Pricing
Because the business model of DSM NIAGA is unique, its pricing method is very different from those of linear businesses. Even though the method is different, the total price is similar to those of linear businesses. For example, the reversible adhesive is more expensive than the latex adhesive that is currently used. However, it will be balanced out by the price of the machine.

Success factors
DSM NIAGA finds success factors in the balanced success of all the actors in the network. Every actor should benefit from the CBM and earn profit that is not too lopsided. Protecting vulnerable actors, especially at the beginning stage, is critical to the success of the business. This ensures that there are benefits to recycling used carpets rather than burning them to gain energy. The company believes that such movement should be initiated by the industry, not by the top-down approach of the government. The industry will find the incentives in the market rather than being pushed by the government.
Challenges

Changing the traditional deep-rooted methods of the current industry is challenging. The business model of DSM NIAGA requires carpet manufacturers to purchase new machines. Even though the machine offers greater benefits, buying one is not a simple decision for the manufacturers. Competition with traditional carpet machine manufacturers is also one of the reasons that makes it difficult to convince carpet manufacturers to use the new carpet machine. Furthermore, unlike other bulky waste materials, no specific regulation is applied when throwing away used carpet. Therefore, used carpets can be thrown away anywhere, which makes it very difficult to collect them.

Because the technology of DSM NIAGA is new and disruptive, it will take some time to improve and reach high efficiency. Some doubts about the function of the technology also work as a risk. However, this is a common challenge for any disruptive technology.

4.3.3. Summary

The circular business model of DSM NIAGA attracts the carpet industry for several economic benefits. Considering the carpet industry is a material-intensive industry, recovering polyester in used carpets saves a considerable amount of the cost, by reducing the amount of virgin material purchased. Moreover, using waste as a raw material stabilizes the material cost. Besides the circular value, the company also brings additional value by having a positive impact on health as it doesn’t give off gas and by making carpets washable. The company believes that some changes in policy and legislation can accelerate the penetration of recycling into the market; however, the economy should recognize the value rather than being pushed by regulations. DSM NIAGA adapted the business model canvas by adding the residual value of used carpet and showing the change of the value added by each step in the flow of material. The company finds success factors in forming a balanced network from which every actor can benefit. Changing the traditional way of producing carpet with many different materials is a challenge for the penetration of recycling.
Van Houtum produces toilet hygiene supplies such as toilet paper, soap, air fresheners, dispensers and non-fixed interior products for restrooms. The company practices a high level of environmental performance in the production process through a Cradle to Cradle certificate as well as a corporate social responsibility by focusing equally on People, Planet and Profit. This Dutch family-owned company is located in the province of Limburg and has been in the business more than 80 years. Among several other brands that Van Houtum owns, Satino Black focuses on sustainable designs using circular values. Among various products of Satino Black, this research looks into the business model of Satino Black toilet paper that is made of recycled paper. The company tries to accomplish the circulation of paper by returning the recycled paper to the customer who provided waste paper. The company enabled the closure of the loop by binding all the actors in the network through a contractual relationship. This was necessary as the company had limited influence or control on the current circulation of waste papers. This case study analyzes the contract with ABN AMRO and the network formed for the contract.

Current State
Van Houtum argues that the current linear business model is dead and that nobody is making a profit from it anymore. The current waste paper flows in a global scale. In the Netherlands, the efficiency of paper collection reaches 95% and 50% of the collected papers is exported to China, a country with a limited capacity of self-sufficing the demand on paper. In China, the waste paper becomes carton boxes. Therefore, it is difficult to track the path of waste paper which makes it impossible to close the material loop.
Future
One and a half years ago, Van Houtum invented a way to recycle products containing waste paper such as juice carton and disposable coffee cups. Through this invention, the company plans to expand their business to recycling used paper cups for two reasons. Firstly, waste writing paper is getting scares due to digitalization and large demand of waste paper from China. It resulted in the price of waste paper soaring higher price than paper made of virgin materials. Secondly, the residual value of the used cups is not recognized in the market and which reduces competition. Currently, the used cups have a negative value which means that the cup does not have any market price and that it only costs money to throw them away. This would allow the paper cups to circulate without having anyone to keep the ownership. Each actor will be paid for their value-adding activities such as collecting, recycling, and delivering. This would entail a radical change in the roles of actors and the relationship between them as the role of the actors between the company and end users are minimized. The reaction of actors could vary depending on their position. The company finds an opportunity in closing the loop of paper cups as the market of a waste coffee cup is still young compared to other waste paper materials. Furthermore, the company plans to expand their circular values to other brands and other materials they use, such as plastic for a toilet paper dispenser.

4.4.2. Results

Circular Business Model
There was a turning point in this business model, changing their strategy from approaching dealers of hygienic product supply to directly contacting end users. The company’s circular value was not recognized by the dealers, but it was much more appreciated by the end users who hold the actual power to change the existing value network. Once the end users were convinced of the value of Satino Black toilet paper, they took the initiative of bringing other actors to the table to form a network.

Circular Value
The primary goal of implementing CBM is to secure raw materials for manufacturing and achieve profit stabilization. This gives firms a stable and favorable raw material price, which allows them to have a stable and long-term relationships with customers. Customers can benefit from low prices, and their demands for sustainability can be fulfilled, which is difficult for them to achieve by themselves. Van Houtum measures and evaluates their value by using key performance indicator (KPI) and through the regular publication of financial, environmental, and social reports.
<table>
<thead>
<tr>
<th>Goal</th>
<th>Advantage</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securing raw material</td>
<td>Long-term customer relationship</td>
<td>KPI</td>
</tr>
<tr>
<td>Profit stabilization</td>
<td>Price advantage</td>
<td>Publication</td>
</tr>
</tbody>
</table>

*Table 9. Circular value of Van Houtum*

**Value network**

In the value network of Van Houtum, there are four parties involved in one contact supplying toilet paper to one customer. As the end-user already had a contract with suppliers and collectors, the waste material circulates through those actors giving them a powerful position in the network.

![Flow diagram of Van Houtum](image)

*Figure 27. Flow diagram of Van Houtum*

**Van Houtum - Manufacturer**

Van Houtum is a manufacturer of toilet paper that is made of waste paper from offices. Through its contracts, Van Houtum receives a fixed amount of waste paper that is collected by traders. Van Houtum produces high-quality toilet paper and sends it to the dealer. Because the product of the company has unique (circularity and environmental friendliness), the company approaches the end users directly because doing so is more effective than going through dealers.

**Dealer**
The dealer provides hygienic supplies for end users, including toilet paper. A dealer normally signs a contract with a customer to supply a various range of hygienic supplies, allowing their customers to benefit from one-stop shopping. The interest of the dealer is satisfying the needs of its customers, such as fulfilling their sustainable procurement criteria. Without a specific request from customers, dealers are normally not interested in sustainable products. When Van Houtum contacted several dealers introducing its product, very little attention was paid to the circular value in the product. This leads the company to skip the dealers and contact the end users directly.

Trader

Traders are waste collectors who collect diverse types of waste materials from contracted buildings and sell them to different parties who need them. Various types of traders exist, depending on which activities they include in their business models: types of waste (paper, glass, plastics, residual waste) they collect, logistics, separation, and so on. In the case of Van Houtum, the trader collects waste paper from different sources and sends bulk waste paper based on the agreement in a four-party contract. The interest of traders is securing a customer base to have a stable supply of waste and increase the value of waste. Traders have two sources of revenue, the fees they charge to ABN AMRO for collecting waste and the revenue from selling the waste to parties that need the waste based on its value.

<table>
<thead>
<tr>
<th>Actor</th>
<th>Manufacturer</th>
<th>Dealer</th>
<th>Trader</th>
<th>End-user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Act</td>
<td>Van Houtum</td>
<td>Hygienic paper provider</td>
<td>Waste trader</td>
<td>Large corporations e.g. ABN AMRO</td>
</tr>
<tr>
<td>Function</td>
<td>Producing toilet paper from waste paper</td>
<td>Provide hygienic supplies</td>
<td>Collect waste from offices</td>
<td>Use toilet paper</td>
</tr>
<tr>
<td>Role</td>
<td>Produce sustainable and high-quality toilet paper</td>
<td>Looking for products that satisfies the need of customer</td>
<td>Collect waste from difference sources and send it to recyclers</td>
<td>Arranging contract with parties for procurement</td>
</tr>
<tr>
<td>Action</td>
<td>Produce quality toilet paper from waste paper</td>
<td>Supply the toilet paper of BBC to end-user based on their needs</td>
<td>Collect waste paper from number of offices and send it to Van Houtum</td>
<td>Bringing all actors to the table</td>
</tr>
<tr>
<td>Interest</td>
<td>Producing sustainable hygiene paper, securing stable supply of waste paper</td>
<td>Securing customer base, fulfilling the needs of customers</td>
<td>Securing waste supply, higher waste paper value</td>
<td>Cutting expenditure on toilet paper, sustainability procurement</td>
</tr>
<tr>
<td>Relationship with Van Houtum</td>
<td>Four-party contract</td>
<td>Four-party contract</td>
<td>End customer, Four-party contract</td>
<td></td>
</tr>
</tbody>
</table>

*Table 10. Actor analysis of Van Houtum*
ABN AMRO - End Users
Van Houtum directly contacted ABN AMRO to offer its circular toilet paper. ABN AMRO already had a contract with a dealer who supplies various office supplies and a trader who collects paper waste from its office. To purchase the toilet paper from Van Houtum, ABN AMRO brought the dealer and trader to the table and formed four-party contract. This five-year contract includes fixed volumes and prices for the supply. In this way, ABN AMRO meets their sustainability ambitions by purchasing sustainable products and guaranteeing waste paper circulation. As a firm in the financial sector, the direct business activities of ABN AMRO are limited in terms of reaching sustainability. Therefore, they are active in seeking solutions with which to accomplish their agenda. Consequentially, end users are the most driving elements of the CBM of Van Houtum.

Other actors
Van Houtum works with the Eindhoven University of Technology to research the separation of cellulose at low temperatures. This research is funded by the Dutch government to facilitate the development of the CE.

Value Proposition
Among the various products of Van Houtum, the author of this paper looked into Satino Black Toilet Paper White, which is made of waste paper. The product is the world’s first cradle-to-cradle certified toilet paper since 2010 that only uses natural and biologically-friendly ingredients without excess complexity, and the production process is CO₂ neutral. The target segment of Van Houtum is large corporations, the service industry, the leisure industry, and schools. The company is not active in the consumer market. It focuses on the B2B market.

Value for customers
Customers can achieve their sustainability goals with minimum effort and investment by purchasing the toilet paper from Van Houtum. This is critical to the customers whose business is not directly related to manufacturing such as customers in finance.

Value for environment
Compared to the existing process, Van Houtum reduced the use of chemicals, energy and water in its manufacturing process. Furthermore, the process only uses green energy, achieving CO₂ neutral. By producing toilet paper from 100% recycled paper, the same amount of raw materials is saved.
Value Architecture

Legislation
At this moment, there is much legislation that hampers more than helps. Some waste-related legislations that are based on traditional waste recycling hamper the business of Van Houtum, such as restrictions on transporting waste across borders. Through the associations of paper factories in the Netherlands, players in the industry are trying to revise the related laws.

Business Modelling Tool
The company tried out many different business modeling tools and currently uses the business model canvas. The tool performs its role by clarifying what the company wants and to where the company should move on.

Organizational Structure
The organizational structure of Van Houtum is different than those of regular linear toilet paper companies. Usually, a sales department targets dealers who supply office supplies to end users, such as banks, hotels, and schools. However, due to the circular value of the toilet paper of Van Houtum, the company runs a sales team that directly communicates with the end users. This is a very efficient way of making sales because the end users are keen on pursuing circular values while dealers have a strong focus on low prices.

Value Finance
Cost and Revenue
Currently, the largest part of most costs is spent on purchasing waste paper. However, this is expected to change in the future. Van Houtum expects that the waste material will not be charged; instead, the value-adding activities to the waste will be the object for charging. Therefore, the waste material will be sent to Van Houtum for free, so their cost will be on personnel and energy use during the process of changing waste to product.

Pricing Method
Now, the price of their toilet paper is fixed based on the agreement of the four-party contract. This is because the current system makes each actor to buy the material and sell it to another actor after increasing or decreasing its value. In the future, however, Van Houtum expects that it will charge its customers for adding value to waste instead of setting the price of toilet paper. The material passes Van Houtum in the circulation process instead of being bought and sold to different actors.
### Current | Future
---|---
**Cost** | Purchasing waste paper | People and energy
**Revenue** | By selling value added toilet paper | By value adding activity on waste paper
**Pricing** | Fixed price and amount of toilet paper based on the four-party contract | Charging for value adding service, not for a product. No ownership of material or product

*Table 11. Value Finance of Van Houtum*

**Success factors**
Van Houtum finds that one success factor of its CBM is discovering and fulfilling the needs and interest of actors in the network. Making all actors to believe that they can benefit from the CBM is critical to success. Because the implementation of a CBM requires a significant change in every actor’s business model, all the parties should have positive perceptions about participating in a circular network.

To form such a value network, the company started from joining the existing network of the end user instead of forming a new network. The starting point of Van Houtum to form the network was directly contacting the end-user. Therefore, instead of finding the actors who can connect them to the end user, the end user involved the company in their network which was much easier than forming a completely new network. The company found changing the existing chain of paper collection that has been complex and long lasting a very difficult to tackle in a short period of time. In the case of Van Houtum, the end user who acknowledged the circular value of the company took the lead and arranged the value network with the existing actors such as dealer and trader.

**Challenges**
Bringing all the parties together and redesigning their roles is the most difficult part. This process requires rather radical changes in their ways of thinking and business models. Therefore, accepting change is a complicated and difficult task. What makes the process even more challenging is the current sub-contracting culture that involves many parties in the network. The absence of a major waste trader resulted in many small traders and sub-contractors forming a chain and dividing the collection of materials and its market. The long chain makes it difficult to manage the different interests of each actor.
4.4.3. Summary

The business model of Van Houtum aims to close the loop by returning the recycled toilet paper directly to the customer who provided the waste paper. This offer of the company tackles the sustainability agenda of their end users who can hereby easily achieve their sustainability goals. To encourage the end users to involve Van Houtum in their existing network of toilet paper supplier, a dealer, and waste paper collector, a trader. This resulted in signing a four-party contract enabling a stable business amongst them. Direct contact with the end users who value the business of Van Houtum was the success factor of their business model and without the help of end user, forming a value network still remains a big challenge.
5.1. Circular Value
5.2. Value Network
5.3. Value Proposition, Architecture, and Finance
5.4. Success Factors and Challenges
5.5. Business Modelling Tools
5.6. Summary
5.1. Circular Value

Circular Value

Circular value a unique value that is generated from CBMs that which cannot be found in linear business models. In total, five circular values are identified: reducing waste, reducing raw material usage, reducing pollution, improving profit stabilization, and improving network relations. Three of the values are related to environmental aspects, and two of them are related to economic aspects. The value of Van Houtum is more focused on the economic aspect compared to the other two cases. The reason can be found that the value of the business model of Van Houtum comes from economical attractiveness than the paper recycling which has been existing for a long time. On the contrary, the value of the other two cases is found in the novelty in the recycling process.

<table>
<thead>
<tr>
<th></th>
<th>Black Bear Carbon (tire)</th>
<th>DSM NIAGA (carpet)</th>
<th>Van Houtum (paper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing waste</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Reducing raw material use</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Improving polluting process</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit stabilization</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Stakeholder relations</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Table 12. Circular values of identified from case study

Reducing Waste

The circular value that is generated from a CBM is reducing the waste that ends up in incinerators or landfills. Both of tire and carpet waste have low recycling rates, even though the residual values of these products are high at the end of their lifecycles. More than 50% of the waste tires are burned or land-filled worldwide. Only 3% of carpets are recycled, 37% are burned, and 60% go to landfills. In case of paper, 95% of papers are collected in the Netherlands and 50% of them are shipped to China.

Reducing Raw Material Usage

Tackling material scarcity is another value of CBMs. By producing products that are recyclable, used products become the raw materials for new products. Because there are always some material losses during the recycling process, some input of virgin materials is inevitable. However, the amount of virgin materials used in production will be remarkably reduced. Because no alternate materials can be found, used materials are the only materials that can replace virgin materials.
Improving Polluting Process
The process of treating raw materials, such as crude oil, can have heavy environmental impacts. By using waste materials, the current pollution process can be skipped or improved. Normally, a recovery process of waste materials is not as energy-intensive as obtaining virgin materials. Moreover, toxic substances that were not filtered in the first place can be removed during the recovery process.

Profit Stabilization
Pursuing a CBM is most valuable in industries to reduce price volatility related risks. Van Houtum stabilized their profit by multi-party contract, fixing the price and volume of the toilet paper they produce and also the waste paper they receive from the trader.

Stakeholder Relations
CBM is fundamentally based on the cooperation between actors in the network. Each actor’s role is unique and not easily replaceable or modifiable. Therefore, the cooperation between actors is critical to the success of the business. Forming the circular network and having every actor in the network benefit from the business is an important value of CBM.

5.2. Value Network

Actor Analysis
Supplier
The role of suppliers in CBM is different than that of suppliers in linear business models. In CBM, suppliers process waste to recover the material that remains in the waste. Upcycling occurs when a recovered material is upgraded in terms of quality or performance. The relationship between suppliers and manufacturers is much closer than it is in a linear business model because the suppliers need to meet the requirements of the manufacturers in the material recovery process. Sometimes, the jobs of suppliers and manufacturers are combined by one actor to optimize the process.

Manufacturer
The roles of manufacturers in this research vary by case. In the case of BBC, the tire manufacturer tests the carbon black to best fit their existing products through close cooperation with the supplier. In DSM NIAGA, carpet manufacturers purchase the carpet machines and adhesive from the company.
and continue their relationship based on licensing contracts. In Van Houtum, the company is a toilet paper manufacturer and the supplier of the recovered material at the same time.

Collector
The collectors who collect waste from different locations are sometimes called traders or recyclers, depending on the industry. The scope of collectors is diverse. Some collectors remove waste from the original place, some do sorting, and some are only involved in the transportation of waste. Moreover, there are collectors who only collect one type of waste and collectors who collect different types of waste from one or multiple locations based on contracts. This makes it difficult to close the material circulation because the sources of collected waste are various. The waste collection arranged by the association of tire manufacturers is very helpful in implementing CBMs. Therefore, other industries can benchmark from the tire industry.

End-User
The result of the case studies shows the three main reasons why end users purchase circular products: to fulfill their sustainability ambitions, to enjoy the health-related features, or for better performance.

Knowledge Provider
In circular business models that involve radical technology, knowledge providers play a critical role. DSM NIAGA was the starting point of forming their value network providing the fundamental technology. However, knowledge providers in circular value networks have limited influences on the network because they are not direct actors in the material flow. For their knowledge to be utilized, waste should be returned to manufacturers for recycling, and some recovery actions are required by the part of actors in the network. To ensure this to happen, a subscription model in which the ownership of a product is maintained by the manufacturer instead of being sold to the customers. However, it is directly connected to the business model of the manufacturer which is out of the reach of a knowledge provider. This emphasizes the importance of cooperation between actors.

Relationship
Each network has different ways of strengthening the relationships between actors. Each case has some actors who are in the network but does not directly interact with the focal firm. The firm still pays attention to such actors to keep them in the network even though they do not have any formal relationships between them. The actors that are important but can be replaced by others have contract-based relationships with the focal firm. Contracts tie the relationships between the actors and the firms. However, the contract is not very difficult to break. Lastly, each company
creates strong relationships with the actors that are critical to the business by establishing joint-ventures or through close collaboration.

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Black Bear Carbon</th>
<th>DSM NIAGA</th>
<th>Van Houtum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Mutual interest</td>
<td>No relationship</td>
<td>✓</td>
</tr>
<tr>
<td>Collector</td>
<td>Partnership + Licensing</td>
<td>No relationship</td>
<td>Multi-party contract</td>
</tr>
<tr>
<td>End-user</td>
<td>No relationship</td>
<td>No relationship</td>
<td>Mutual interest</td>
</tr>
<tr>
<td>Knowledge provider</td>
<td>N/A</td>
<td>✓</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 13. Cross-case analysis in the relationship with actors

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No relationship</td>
<td>Attention</td>
<td>Actor is in the network but not directly exchanging any influence.</td>
</tr>
<tr>
<td>Licensing</td>
<td>Contract</td>
<td>Exchange product/service and fee based on licensing contract.</td>
</tr>
<tr>
<td>Multi-party contract</td>
<td>Contract</td>
<td>A stable relationship based on contract.</td>
</tr>
<tr>
<td>Mutual interest</td>
<td>Tied relationship</td>
<td>A close relationship, influence each other via communication or joint research.</td>
</tr>
<tr>
<td>Partnership</td>
<td>Tied relationship</td>
<td>Aligned interest. Strong cooperation.</td>
</tr>
</tbody>
</table>

Table 14. Cross-case analysis in the degree of relationship

5.3. Value Proposition, Architecture, Finance

Value Proposition

Target Segment

The three companies all target major large manufacturers or consumers in the market. Because the major players in the market are powerful and influential in the industry, it is critical to have such powerful customers in the initial stage. It is likely that market leaders are keen on pursuing sustainability. Therefore, it eases the initial access to the firms.

Value for Customer

The three companies all serve the fulfillment of their customers’ sustainability agendas. By purchasing circular products, customers indirectly meet their sustainability goals. Two companies also contribute to lowering the expenses of their customers. The customers of DSM NIAGA can reduce their energy and water bills because the machine of DSM NIAGA requires much less water and energy than existing machines. The four-party contract of Van Houtum lowers prices for customers.
**Value for Environment**

All the CBMs reduce the use of raw material and the amount of waste that goes into landfills or incinerators. The circular process also requires less energy than the traditional process resulted in either net CO$_2$ neutral or positive. BBC generates oil as a by-product of their process and that are used as a sustainable / green energy sources. While a normal carpet manufacturing process requires 0.7 liters of water per square meter of carpet production, the process of DSM NIAGA does not require water at all. Van Houtum uses few chemical products, and it uses green energy sources to minimize its environmental impacts.

**Value for Society**

During the circular process, BBC and DSM NIAGA eliminate toxic materials from waste materials, and Van Houtum uses few chemical products in its processes. The three companies offer healthy products to customers through circular products. CBMs also creates jobs. BBC applies a non-discrimination policy in hiring and creates jobs in rural areas. The small, energy-efficient machines of DSM NIAGA enable the dispersion of factories, which also creates jobs in small regions.

<table>
<thead>
<tr>
<th>Value for customer</th>
<th>Meet sustainability goal</th>
<th>Low utility or purchasing cost</th>
<th>Product customization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BBC, DN, VH</td>
<td>BBC, DN, VH</td>
<td>BBC</td>
</tr>
<tr>
<td>Value for environment</td>
<td>Less raw material use /</td>
<td>Net CO$_2$ positive or neutral</td>
<td>Less energy use</td>
</tr>
<tr>
<td></td>
<td>landfill / incineration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BBC, DN, VH</td>
<td>BBC, DN, VH</td>
<td>BBC, DN, VH</td>
</tr>
<tr>
<td>Value for society</td>
<td>Removal toxic material</td>
<td>Creating jobs in rural area</td>
<td>Less chemical ingredient</td>
</tr>
<tr>
<td></td>
<td>BBC, DN</td>
<td>BBC, DN</td>
<td>VH</td>
</tr>
</tbody>
</table>

*Table 15. Cross-case analysis of value incorporated into the offering*

**Value Architecture**

**Legislation**

The three companies agree that, in general, the current legislation on waste hinders their business because it was established based on the traditional view on waste. The value in the new way of treating waste or its result is not recognized in the old legislation. It has been slowly recognized by governments at both national and the EU levels, and the manufacturers’ associations lead efforts to bring the change as soon as possible. Some government subsidies on material recovery also show that the change is coming. In the future, the companies expect the legislation to be changed in positive ways that promote waste recycling as a common practice.
Business Modelling Tool
The most commonly used business modeling tool by the three companies is the business model canvas. Even though the use of the tool varies in each company, they agree that the tool gives clarity about their business models. BBC used this tool after completing its business model to have a clear view of each element. DSM NIAGA added the residual value factor to the canvas to make the value after the consumer phase highly visible. Van Houtum uses the business model canvas to look to the future of the company.

Value Finance
Revenue
The main source of revenue for BBC is the sales of carbon black and some by-products that are generated when processing ELTs. DSM NIAGA earns profit from the sales of a set of technology, machines, and adhesive, as well as the licensing fees they charge carpet manufacturers per square meter of the carpet made using its machine. The revenue of Van Houtum comes from contracted sales of toilet paper.

Pricing Method
Unlike revenue streams and cost structures, the pricing methods of the three companies vary. BBC simply uses market price based on comparison to virgin carbon blacks it would replace. The customers of DSM NIAGA also pay similar amounts for the carpet production compared to what they would pay for linear products. However, the price is formed in a very different way compared to a linear product. Looking into the price segment of the set of technology, machine, and adhesive that DSM NIAGA offers, some elements are more expensive than the market price, and some are
lower. The company balances out the high and low-price elements, so the final price the customer has to pay is similar to the current market price for the product. Van Houtum discusses its prices with other parties in the network because it is in a multi-party contract.

<table>
<thead>
<tr>
<th>Black Bear Carbon</th>
<th>DSM NIAGA</th>
<th>Van Houtum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue stream</strong></td>
<td>Product sales, licensing fee, by-product</td>
<td>Package sales, licensing fee</td>
</tr>
<tr>
<td><strong>Cost structure</strong></td>
<td>Confidential</td>
<td>Material-intensive</td>
</tr>
<tr>
<td><strong>Pricing method</strong></td>
<td>Confidential</td>
<td>Balance out</td>
</tr>
</tbody>
</table>

*Table 16. Cross-case analysis of value finance*

### 5.4. Critical factors

**Similarities**

All the three companies found it important to identify and understand the interests, needs, and benefits of all the actors in the network. Without a positive perception of the actors toward the circular business, the network would not work. It is important to spend enough time and communicate with actors to discuss and balance the benefits of being part of the circle. Especially because CBM is a new concept, in some cases, it requires a significant change in the way the actors run their businesses. Every actor should be convinced and be able to benefit from the new way of business.

Ironically, bringing all the actors in a circular network together is the biggest challenges that the companies are facing. Finding the actors and rearranging their roles and ways of doing business is not an easy task, especially when an actor had a negative experience in the past with recycled material or just has a negative perception on waste. This prevents the network from moving forward. Bringing change in the usual way is very challenging, especially when the actors like to have autonomy. Once the challenges are overcome, they become success factors.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Success factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change</td>
<td>The new way</td>
</tr>
<tr>
<td>Benefit</td>
<td>Higher return</td>
</tr>
<tr>
<td>Risk</td>
<td>Radical innovation</td>
</tr>
<tr>
<td>Quality</td>
<td>Improved</td>
</tr>
<tr>
<td>Perception</td>
<td>Positive experience</td>
</tr>
</tbody>
</table>

*Table 17. Cross-case analysis of success factors and challenges*
DSM NIAGA had another challenge that comes from using disruptive technology. The higher efficiency of a technology can be achieved through accumulated time and experience. In the period when the companies are still working on the improvement of technology or its efficiency, the cost of the production is relatively high compared to the existing firms who have been in the industry for a long time. Therefore, competing with those incumbent companies comes as a challenge until their new technology is settled which eventually would lead to the decrease of production cost.

**Differences**

Different critical factors are found depending on the characteristics of the products that the companies produce. BBC emphasized the importance of quality of the carbon black because carbon black is a highly technical product. Especially there has been a negative perception of the quality of the recycled carbon black, BBC puts emphasis on providing a product that offers positive technical value.
5.5. Summary

The result of the cross-case analysis is summarized in the following table:

<table>
<thead>
<tr>
<th>Circular value</th>
<th>Black Bear Carbon</th>
<th>DSM NIAGA</th>
<th>Van Houtum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspects</td>
<td>More environmental</td>
<td>Environmental –Economic balanced</td>
<td>Environmental –Economic balanced</td>
</tr>
<tr>
<td>Measurement</td>
<td>LCA - CO₂</td>
<td>Saved virgin material</td>
<td>KPIs</td>
</tr>
<tr>
<td>Company role</td>
<td>Supplier</td>
<td>Knowledge provider</td>
<td>Supplier/Manufacturer</td>
</tr>
<tr>
<td>Important relationship</td>
<td>Partnership + licensing with collector</td>
<td>Licensing with manufacturer</td>
<td>Multi-party contract through end user</td>
</tr>
<tr>
<td>Value for customer</td>
<td>Sustainability, economic, customization</td>
<td>Sustainability, economic</td>
<td>Sustainability, economic</td>
</tr>
<tr>
<td>Value for environment</td>
<td>Less raw material use / landfill / incineration / energy use</td>
<td>Net CO₂ positive</td>
<td>Net CO₂ neutral</td>
</tr>
<tr>
<td>Value for society</td>
<td>Health, job creation</td>
<td>Health job creation</td>
<td>Health</td>
</tr>
<tr>
<td>Legislation</td>
<td>Positive: Subsidy</td>
<td>Positive: Subsidy</td>
<td>Positive: Subsidy</td>
</tr>
<tr>
<td>Tool</td>
<td>BMC for checking</td>
<td>Modified BMC</td>
<td>BMC for future plan</td>
</tr>
<tr>
<td>Revenue stream</td>
<td>Product sales, by-product, licensing fee</td>
<td>Package sales, licensing fee</td>
<td>Product sales</td>
</tr>
<tr>
<td>Cost structure</td>
<td>Confidential</td>
<td>Material-intensive</td>
<td>Present: material-intensive</td>
</tr>
<tr>
<td>Pricing method</td>
<td>Confidential</td>
<td>Balance out</td>
<td>Contract-based</td>
</tr>
<tr>
<td>Success factors</td>
<td>Network, Quality</td>
<td>Network</td>
<td>Network, fulfilling needs of customer</td>
</tr>
<tr>
<td>Challenges</td>
<td>Resistance of existing network</td>
<td>Complexity of existing network</td>
<td></td>
</tr>
</tbody>
</table>

*Table 18: Summary of cross-case analysis*
6 Discussion

6.1. Findings

6.2. Implications
6.1. Findings

6.1.1. Circular Business Model

Lewandowski (2016) defined CBM as “utilizing the economic value retained in products after use in the production of new offerings”. This definition fails to differentiate CBM from a regular business model using recycling which has existed prior to the appearance of CBM. The focus of the existing definition is limited to using the residual value in the waste.

The case study shows that the aim of CBM is achieving higher level of recycling meaning the recycled material has higher value than the virgin material. Therefore, this research adds the aspect of upcycling to the definition of CBM that a product of CBM should offer more than what a product made of virgin materials offers through its regenerative process. Upcycling can be achieved by adding values such as higher quality, superior performance or less impact on environment or on humans from the product or its manufacturing process.

Adding the aspect of upcycling to the definition of CBM is important because it narrows down the gap between academia and industry in terms of understanding of CBM. This would allow more efficient and effective communication and interaction between them. Furthermore, this will contribute to the shift of waste policy focus from ‘waste to energy’ to ‘waste to material’. By highlighting the added value of material recovery, the value that is lost in energy recovery will become clearer. Therefore, it legitimizes the shift of focus to material recovery.

6.1.2. Circular Value Network

The importance of collaboration in a value network has been recognized in the literature review. Ghisellini et al. (2016) argued the key to accomplish circular economy is in the involvement of stakeholders in suitable collaboration and it is also found in the business modelling frameworks of Antikainen & Valkokari (2016) and Al-Debei & Fitzgerald (2010). The research finds the value network is the most critical success factor of CBM. Implementation of CBM starts with the formation of circular value network through finding the right actors who share the same value. Through the network, actors collaborate on fulfilling the goals of the network as a whole and also the individual goals of each actor.

Challenge
Arranging the role of actors and establishing a new network is a challenge, especially in some sectors where the existing waste collection system is complicated with an involvement of multiple
actors. It is very difficult to make a change a deeply-rooted system that has been lasted for a long time. Therefore, understanding the needs, benefits and disadvantages of actors are critical in the formation of network. Startups who are free from the existing network can mitigate this challenge by setting up a whole new network.

Relationship
This research discovered diverse types of relationships that exist in circular value network depending on the importance of the role of actor. The relationships in circular value network were built on more than a simple contractual-base, often entail aligned interest and mutual interaction. Interestingly, even though some actors in the network don’t share direct interest between them, continuous attention was paid to keep all the actors in the network to maintain circularity as a whole.

Balance
A circular value network brings more balanced development among the actors in the network due to the strong symbiotic relationship amongst them. This becomes more obvious when it is compared with linear business models where a lopsided relationship is commonly seen. Because the formation of circular value network starts from considering the interest of each actor, it brings a more balanced relationship to the network which leads to the positive impact on industries.


The literature review introduced various business modelling tools and frameworks highlighting the importance of business modelling tools. However, the study shows that firms who pursue CBM have limited use of the existing business modelling tools or don’t find it useful in the implementation of CBM. This shows that the existing tools do not capture the circular value. Although the business modelling tools for sustainable business models present more various voices than a regular tool, it still misses some qualities regarding CBMs. Because the value network of a CBM is one of the most critical factors in the success of CBM, the tool must be able to clearly describe it. The tool should efficiently visualize a flow in the network and highlight relationships along the flow. A recognition of the residual value in the waste is another unique factor of CBM that should be emphasized in the BM tool to have an effective and complete BM tool. Furthermore, because CBM is still at the initial stage and evolving continuously, a tool for it should be flexible focusing on the core values of the business model. A simple tool that is flexible would be ideal for a tool for CBMs.
A new CBM tool should include an element of measuring circularity. The study shows that companies measure sustainability by Life Cycle Assessment, however, not circularity. One of the reasons can be that the parameters for measuring circularity do not exist. The element of measuring circularity can be added to the tool.

6.2. Implications

The result of this research suggests some changes in the different aspects of society. Those are described in the framework of PASFEL (political, academic, social, financial, economic, and legal) analysis. Subsequently, some practical implications towards firms that are deducted from the study are explained.

Political Factors
Current waste policies and subsidies encourage waste-to-energy recycling, which destroys most of the value in the waste. This has been discouraging firms from seeking new efficient ways to use waste. To advance the transition to CE, governments should provide subsidies, tax benefits, and incentives to companies with CBMs to assist and encourage them and attract other companies to join. Furthermore, policy should impose more responsibilities on product manufacturers regarding their products after their lifecycles and the use of raw materials. For example, imposing some additional taxes on the use of raw materials will lead companies to find ways to replace the raw materials.

A country- or continent-level of a roadmap with aligned goals toward a CE is encouraged to bring synergy, instead of having different policies every region. Lastly, government procurement should put weigh on circular products and services in their selection criteria because government procurement is not only for large amounts of orders, but also very influential throughout the industry.

Academic Factors
Clear definitions of circular business models in academia are missing at this moment. Particularly, the relationship between CBM and SBM is very unclear. In some parts of academia, CBM is seen as a sub-category of SBM, and in others, the two concepts are separated with some overlap. The current definitions are not aligned and causing confusion in the industry. Therefore, the definition of CBM and its boundaries need to be further researched and verified. To ease the spread of the concept, a clear definition that is accepted in large part of the world is required. This will prevent the concern that having different definitions resulted in different futures, suggestions, and results.
This is not necessarily bad for the development the CBM. However, because the concept is in the initial stage and not yet mature, some aligned focus could be helpful.

**Social Factors**

For companies with CBMs to be successful, the social perception of waste should be changed. The existing perception is based on the past when waste was considered to have no value and recycled products were low in quality. Realizing resource scarcity and waste issue should be recognized not only by industries but also by the society in order to facilitate the CE. To achieve that future, the habits of consumption, disposal instead of repair, purchasing more than necessary, and disposal of recyclable material should be changed in society. When purchasing a product, selecting recycled product or product that is easy to recycle can be helpful. In the product as service business model, some behavioral changes are required because consumers will be paying for the use of than the ownership of the product.

**Financial Factors**

CBMs will bring some significant changes to the finance sector, including banks and investors. The recognition of the residual value of a product at the end of its life and the extended return period of investment should be accepted and supported by the financial sector. First of all, currently the residual value of waste has not been taken into consideration. Therefore, it has not been measured or recognized as a value. A reasonable way to measure such residual value and regenerated value in should be agreed upon. Secondly, a long-term recovery period of investment is expected in the...
CE, especially for the product as service business model in which the ownership of a product stays with the manufacturer while customers pay for the services that fulfill their needs. This business model will prolong the return period of a manufacturer compared to the current business model in which they pay for a product at the moment of a sale. Because the return period is extended, the financial sector might take it as an increased risk and try to avoid investing in companies. Therefore, deep research and solutions that can be agreed upon by both the financial sector and industry are required prior to the transition to a CE.

**Economic Factors**

The current global economy is an economy in which a product is sourced, manufactured, used, disposed of, and gathered in scattered areas in the world. In the era of CE, the scale of economy is expected to be smaller. We will move from an international scale to a regional scale. Because waste is collected locally and the raw materials of a product are waste, the sourcing of the material will be done on a regional level. This will eventually mitigate the problems of international logistics, including large CO\textsubscript{2} footprints.

The smaller regional economy will allow consumers to have accurate information about the sources of the products they purchase, helping them to make improved decisions. Moreover, by circulating the waste locally will make it easier to track its path. This will make consumers to be more aware of waste issues and try to make changes in their behavior. When the global economy is changed to a regional economy, the waste issue is no longer a matter of a poor country where accepts waste for economic reasons, but it becomes our own problem.

**Legal Factors**

The current legislation on waste and recycling is based on the linear economy, in which products are disposed of at the end of their lifecycles and only a small proportion of them will be recycled with a low material recovery rate. The current legislation mostly focuses on the safe and efficient disposal of waste. This is why the current definition and focus of waste do not match and hinders the transition toward the CE. The current legislation does not recognize the value of the materials left in waste, and this has been hindering the companies that are pursuing CBMs. Therefore, the new legislation on waste should be changed to recognize the value in waste, remove the limitations of material recovery, and foster the CE.
Practical Implications

Few suggestions are made for the companies that do not have a CBM yet, that are looking for a suitable CBM, and that have already implemented CBM.

In the future, the use of CBMs is expected to become a norm in many industries, especially material-intense industries. In the era of CE, circularity will be embedded in most business models. This will entail a paradigm shift of ownership in which the collection of end-of-life products is critical to business, and maintaining ownership eases the collection of waste. This also means that it will entail greater responsibility for manufacturers because they must ensure the circulation of the materials.

Secondly, circular products should have additional element beyond just being circular. There are some customer segments that are intrinsically interested in circular products. However, for the rest of the consumers, the value is not obviously recognized because the circular process is not visible to the end users. Therefore, to appeal to a wide range of customers, additional elements, such as superior performance, quality, efficiency, design, or functionality, should be entailed. Especially because recycled products had negative reputations in the past, it is important to overcome this prejudice by offering extra value beyond circular value.

Thirdly, circular firms should form a solid circular network with actors who share the same belief in circular business. As the name implies, circularity cannot be formed alone. Circular business cannot be achieved without collective effort, and it often involves new actors with new roles in the value chain. Because the concept is new and it often includes radical changes, close cooperation between the actors based on trust is essential. To ensure aligned vision, the formation of consolidated relationships, such as exclusive partnership, is recommended.

Fourthly, startups can bring more radical CBMs to the picture and play intermediary roles in CE. Often CBMs require radical changes in the composition of the network, relationships, and roles, as well as the cost and revenue structure. This involves losing or adding partners, changing the ways of earning a profit and the value they have been pursuing. For the existing, large, and traditional companies that have been maintaining linear businesses for a long time, this could be very challenging work. On the contrary, it is easy for startups to find disruptive solutions because they are free from relationships. Startups can also become intermediaries in the networks of existing linear firms by undertaking the role of the gap between linear business and circular business. However, even though it is difficult to be radical, the influence that large companies bring to the CE could be greater if they use their resources and power in the industry. The impact reaches not
only reaches the main actors in the network but also the second- and third-tier partners, as well as public awareness.

Lastly, enterprises should be prepared for a future in which waste is scarce. In a world in which circular design and CBMs are universalized, the lifecycle of a product is expected to be prolonged and repairing broken product will become easier. This will lead to less waste being generated. Moreover, an increased number of companies with CBMs might cause increased demand for waste materials. The competition to secure waste materials can be a threat to businesses as the prices of waste materials increase.
7

Conclusions, Limitations, & Future research

7.1. Conclusions
7.2. Limitations
7.3. Future research
7.1. Conclusions

The objective of this research is to facilitate the dissemination of CBMs in firms by understanding the prospect and barriers of the implementation of CBMs. The literature review provided a theoretical basis for the research, and the expert interview provided a practical basis for the research. A framework to analyze the different dimensions of CBMs was developed from the existing frameworks and ontologies and was applied to the three cases that are using waste tire, carpet and paper in their CBM. The analysis of each case and a comparison of them bought the discussions on the CBM, circular value network and BM tool for CBMs.

Firstly, this research makes a theoretical contribution to the literature by adding the aspect of upcycling to the definition of CBM. This narrows down the gap between the literature and reality keeping the understandings of both side aligned. Moreover, it drives the policies on waste recycling towards a more favorable way to CBM by acknowledging the additional value.

Secondly, the importance of circular value network in the implementation of CBM has been recognized for the first time. The research provides the analysis of actors, their role, and relationships in the network with a visualization of the material flow between the actors. This recognition contributes as a starting point for the future research on the circular value network. Furthermore, a balanced development among the actors in the network was discovered highlighting the positive impact of CBM in the circular value network.

Thirdly, this research contributes to the development of business modelling tools for CBMs. The analysis of CBMs revealed that some elements that are critical to CBMs but not included in the existing BM tools. Based on the findings, some suggestions were made to the development of business modelling tools that applies to CBMs.

In the industry point of view, this research can function as a reference book for the firms who are considering implementing a CBM. The analysis of the ongoing cases based on the framework for CBMs and the detailed description entailed provides indirect empirical experience. For the policy makers, this research can be used as a guideline on the revision or reformation of the waste policy and legislation. The research gives an overview of the issues that the circular firms are facing and makes suggestions. It is expected to encourage the implementation of CBMs in firms and to remove obstacles in the operation of the businesses.
7.2. Limitations

The most critical limitation of this research comes from the scope of the research which is restricted to the resource-based CBM. This excludes other types of CBM such as Product Service System (PSS) that is one of the well-known and promising CBMs. Among the resource-based CBMs, the selection criteria of cases for case study also acted as limitation concerning the diversity of geographical regions, sectors, and company types. Firstly, the selected cases and experts for this research are all based in the Netherlands. This fact resulted in the researcher neglecting many important differences in the business environments of each country. The differences between countries create recognizable differences in environmental, social, and economic aspects. Each country has different regulations on sustainability, CO$_2$ emissions, energy price, and access to raw materials. In the social aspect, each country has a different level of public awareness of sustainability, consumption, purchasing behavior, and business culture. In the economic aspect, the levels of the economies, advancements in technology, and industrial structures have significant differences in each country, and that affects the business models of firms. Different regulations on waste, such as the radius of waste collection, transportation of waste, taxation on waste, and subsidies on waste processing have significant impacts that can be critical factors in the success of CBMs. Therefore, country-specific research should be conducted in multiple countries to increase the validity of the research.

Secondly, because the researcher looked into cases in diverse sectors, few important factors such as sector-specific knowledge, customs, and regulations were neglected. This is especially important because the legislation on waste is different for different materials. Moreover, the physical and chemical characteristics of the material heavily affect the recycling possibility and process, as well as the value, life span, and use of materials. Therefore, future research in different sectors will help provide a comprehensive understanding of the attributes of different sectors.

Lastly, the elements that firms should consider when implementing CBMs differ depending on the starting point of the firm. The starting points of startups, joint-ventures, and incumbent linear firms that are switching to CBMs are very different, and each type requires different knowledge and expertise. Likewise, startups and incumbent companies have different views on the current market, experience different challenges and have different means by which to overcome challenges. Different types of firms should be researched separately because the outcome of the research can be highly concrete and fine-tuned when based on firm type.
Overall, to overcome the limitations of this research, several different country-specific, sector-specific, and company-type-specific studies on CBMs are expected to follow to provide comprehensive knowledge of CBMs.

7.3. Future research

This research has shown the importance of circular value network in the implementation of CBM. The results of case study describe that each case has a very different shape of value network consists of different actors. There are many elements that decide the characteristics of value network and the individual elements should be looked into separately. The elements are actors in the network, role of each actor, relationship between or among them, and their shared or conflicting interest. The network can be future researched in the categorizing different types of network, focal actor in the network, size of the network, power distribution in the network, dependency in the network, and flow of influence.

Secondly, a research on the improvement of customer perception and behavioural change towards recycled material is required. One of the conclusions of this research is the need of a revision of policy and legislations on waste. This would bring the direct benefits to the firms pursuing CBM and furthermore, it indirectly affects the customer perception. As shown in the research, a negative perspective on the recycled materials brings discordance between sustainability goal and decision on the procurement. It would also prevent a behavioral change which is necessary for the transition to the circular economy. Research on the circular business models should be combined with the research on the customer side to be more effective. This can further increase the demand from the customer side achieving bottom-up approach. Therefore, a research on the customer perception and behavioral change should be looked into for the successful implementation of CBM.


Appendix

Appendix A – Expert Interview Questionnaire

Expert interview

Questionnaire to find the answers to:

How can companies successfully implement Circular Business Model (CBM) further improve it?

Getting started

- What is your name, your function, and organisation?
- What are your activities on the topic of Circular Business Models?
- How did you get involved in CBM and why are CBMs relevant/interesting to you?

Current state and developments

- What is a Circular Business Model (CBM)?
- How is it different from Sustainable Business Model (SBM)?
- What are the main developments for CBM in the Netherlands/internationally?
- What is the goal of CBM?
- What is the motivation of companies to start CBM?
- What are, according to you, the major types of CBM?
- In which sectors CBM is more successful and why?
- What are good cases of circular business models in the Netherlands?
- Which ones do you now better or have you been involved into?

Success factors

- Based on your experience/knowledge, what are the main success factors when implementing CBM?
- What are barriers or failure factors for CBM?
- Is there any disadvantage of CBM or risk involved?
- How can such factors be pre-identified?
- How does CBM perceived by stakeholders?
- How can environmental sustainability be ensured when implementing CBM?
- How can firms move towards CBM? What are good methods and frameworks for this?
- Are you aware of any tool or method to develop CBMs or adjust existing BMs into more circular ones?
The Future

- What does the future of CBM look like? How would it evolve? What are your expectations for CBM?
- What should other actors do on CBM (government, research, others)?
- How can this be further stimulated?
- What factors might hinder this future?

Closing

- Is there anything you would like to add on CBM and its developments?
- Whom would you recommend me to interview too?
- What cases would you recommend as a successful CBM implementation?
Company interview

Questionnaire to find the answers to:

**How can companies successfully implement Circular Business Model?**

**General questions**

What is your name, function, and company?

What is circular economy and why is it important in your view? How does your company work on CE?

What is the type of your company? (multinational, start-up, spin-off, joint venture, ...)

What is the current phase of the business?

What is a circular business model in your view?

What was the motivation of your company to start circular business model?

Does your circular business model apply to the entire company or to a product line?

How did you develop and implement your circular BM? Did you use any business modelling tools such as business model canvas? Do you see a need for a tool for CBM? If so, what should be part of the tool?

What were the challenges during the process? What were the success factors? What have you learned from this? How could you do better/different? Is there a need for (more) external support?

Do you find C2C certificate important in pursuit of CBM?

**1. Circular Value**

What is the primary goal of your company trying to achieve through this CBM?

What is the customer value, environmental value and social value incorporated within the offering that doesn’t exist in linear businesses?

Who are the beneficiaries of the value created from your business?

What kind of advantage does it bring you?

How do you measure or evaluate the value?
2. Value Network
Who are the main actors in your value network and what are their roles and relations with your firm?

How does the material flow in the network?

Is there any conflicting value/interest in the network?

Who are other important actors for your company (e.g. government or universities)?

3. Value Proposition
What is the product or service you provide and who are the target segment?

What is the value that is incorporated to the offering?

4. Value Architecture
What is your key activity, key resource, and key competence?

Is your organization structure different because of CBM?

Did any legislation/regulation complicated or stimulated your CBM?

5. Value Finance
Where does the main cost and revenue occur in your CBM?

Which pricing method do you use and why?

Is there any taxation benefits/subsidy from the government?

6. The future
Do you have any plans to further develop your business model e.g. more circular?

What is the next step of CBM in general?

What are the challenges in realizing that future? How can it be facilitated?

What is needed to diffuse CE and CBM to other companies in your sector/industry?

Closing
What are other interesting cases of CBMs that you are familiar with?

Is there any open data that I can get more information about your company than official website?
Appendix C - Test case: DESSO
in the Modified Triple Layered Business Model Canvas

### Economic Business Model Canvas

<table>
<thead>
<tr>
<th>Partners</th>
<th>Activities</th>
<th>Value Proposition</th>
<th>Customer Relationship</th>
<th>Customer Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn manufacturers</td>
<td>Production</td>
<td>Better air quality</td>
<td>Take-back program</td>
<td>Commercial</td>
</tr>
<tr>
<td>Carpet collection</td>
<td>Upcycling</td>
<td>Luxury design</td>
<td></td>
<td>Residential</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comfort</td>
<td></td>
<td>Hospital</td>
</tr>
<tr>
<td></td>
<td>Resources</td>
<td></td>
<td></td>
<td>Aviation</td>
</tr>
<tr>
<td></td>
<td>Brand</td>
<td></td>
<td></td>
<td>Marine</td>
</tr>
<tr>
<td></td>
<td>Recycle plant</td>
<td></td>
<td></td>
<td>Grass</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs</th>
<th>Revenues</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing</td>
<td>Main revenues:</td>
<td>Carpets</td>
<td>Other: Upcycled yarn, Fractions and Recycled bitumen</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Recycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
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</tbody>
</table>

### Environmental Business Model Canvas

<table>
<thead>
<tr>
<th>Supplies and Outsourcing</th>
<th>Production</th>
<th>Functional Value</th>
<th>End-of-Life</th>
<th>User Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquafil technology</td>
<td>Backing</td>
<td></td>
<td>Take back</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Energy</td>
<td>Non-toxic backing</td>
<td></td>
<td>Recycle</td>
<td>Carpet washing</td>
</tr>
<tr>
<td></td>
<td>Recyclable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fiber and yarn</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Impacts</th>
<th>Environmental Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption of wool</td>
<td>Non toxic materials</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>Saving virgin resources</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Authorities</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Aquafil developed technology to recycle used yarn to new material</td>
<td>C2C certificate</td>
</tr>
<tr>
<td>Required to sign a declaration</td>
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</tr>
<tr>
<td>Media</td>
<td>TEDX</td>
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</table>

<table>
<thead>
<tr>
<th>Stakeholder Impacts</th>
<th>Stakeholder Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Take back program spread to other industries</td>
</tr>
</tbody>
</table>