

Building a Collaborative Advantage within a Circular Economy: Inter-Organisational Resources and Capabilities of a Circular Value Chain

Master's Thesis
Master Sustainable Business and Innovation

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“The woollen coat, for example, which covers the day-labourer, as coarse and rough as it may appear, is the produce of the joint labour of a great multitude of workmen. The shepherd, the sorter of the wool, the wool-comber or carder, the dyer, the scribbler, the spinner, the weaver, the fuller, the dresser, with many others, must all join their different arts in order to complete even this homely production.”

- Adam Smith, 1776

Preface

During my studies for the master Sustainable Business and Innovation I became interested in the circular economy concept. I was fascinated by how sustainability was approached in such a pragmatic way, with just a few leading principles. However, in my belief, the debate concerning this topic did not go beyond those principles and little did it deal with the path of implementation. This understanding motivated me to graduate on this topic. I hope this research will solve some of the difficulties of implementing circularity in today's businesses and will contribute to a new emerging research field of revised economics. The thesis is primarily directed at researchers and people from business, who are either familiar or unfamiliar with the circular economy concept. Policy makers may also reflect upon the findings of this research for their personal endeavours. If one simply wishes to learn more about the circular economy principles, it is recommended to read the beginning of the chapter on theory. For a better understanding of how they can be implemented within the value chain, it is recommended to read the rest of the thesis.

The research and writing of this thesis has largely been conducted as part of a graduation internship at the company Royal HaskoningDHV (RHDHV). RHDHV is an independent, international, engineering, design and project management consultancy company with over 130 years of experience in a variety of markets, such as manufacturing, infrastructure, maritime, aviation, mining, energy, water, urban and rural areas and buildings. As of 2012, the guiding principles of a circular economy became part of RHDHV's consultancy services, but closed loop thinking was already part of the environmental services in the 80's and 90's (J. Kimmel, personal communication, April 16, 2015). In the near future, RHDHV wishes to further specify their role in advising their clients on how they can implement circularity. This thesis will help RHDHV in this exploration.

The graduation project has been supervised by dr. Krishna Manda from the University of Utrecht. I wish to express my greatest gratitude for his help and commentaries on my work. My thanks also go to RHDHV for sponsoring this research, granting access to a vast network, and for the personal supervision I received from Edward Pfeiffer in particular. I further wish to thank Violeta Paginu for her guidance in the company and her companionship at some of the interviews and conferences. I would also like to thank Jan-Paul Kimmel for his provision of material and contacts of pioneering companies. During the course of my research I have interviewed many knowledgeable people from a variety of businesses and organisations. Hereby, I wish to express my gratitude to all those people who have contributed to the findings of this report. In alphabetical order: Geanne van Arkel, Ronald van Bommel, Peter Bos, Dorus Galama, Marc van Gerrevink, Fabienne Goosens, Andy Hall, Sander Jongerius, Jan Jonker, Tom Leenders, Gerald Naber, Violeta Paginu, Edward Pfeiffer, Annemarie Piscaer, Florens Slob, Iris van Wanrooij and Anita de Wit.

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Abstract

A circular economy has major implications for how current supply chains are organised. They need to be transformed into circular value chains, in which companies collaborate to effectively manage complete product value cycles, consisting of the creation, preservation, exploitation and restoration of product embodied values. Earlier research has identified some of the major obstacles to make this transformation come true, but little guidance is provided in how these new circular systems are organised, operated and managed. This thesis contributes filling in this knowledge gap, by the means of creating and testing a theoretical framework comprising the inter-organisational resources and capabilities of a circular value chain. The framework draws upon existing literature from the fields of traditional and sustainable supply chain management, operations- and information management and covers three domains: organisational boundary conditions, operational resources and managerial capabilities. The validity of the framework was put to the test by collecting empirical data from semi-structured interviews with experts and employees from pioneering companies in a circular economy. The analysis of this data resulted in a further exploration of the framework's contained elements, and their relevance to a circular economy. It was found, among other observations, that the existence of trust and a culture of transparency are two very important boundary conditions. Furthermore, sophisticated engineering technologies can greatly improve the circularity of the value chain, while advanced information technologies can improve the relationships and make management easier. Finally, collaboration in the value chain succeeds when partners can identify what extra value is gained by it and when they have found a way to share in this value. Many of the framework's elements are interconnected and thus the transformation depends on the interplay of all those resources and capabilities.

Keywords:

Circular Economy, Closed-Loop, Cradle-to-Cradle, Collaboration, Circular Value Chain Management, Inter-Organisational Resources and Capabilities

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Executive summary

The way in which today's economy functions cannot be sustained. The production and consumption model that mankind inherited from the industrial revolution is growing old and requires a thorough revision. It is characterized by a fast rate of natural resource extraction, resulting in those resources getting scarcer and in higher and more volatile prices. Besides, business models are aimed at selling more and faster, resulting in the relatively short lifetimes of products and the creation of waste. The earth no longer has the capacity to assimilate this waste. Mankind therefore faces some serious challenges concerning the environment and economy. In order to solve those, the economy is required to transition from a linear model of production and consumption to a 'circular' model. In a circular economy, products and materials keep circulating within the economic system, decoupling economic growth from the extraction of primary resources. The three underlying principles are to preserve natural capital, to optimize resource yields, and to foster system effectiveness by designing out negative externalities. It is not surprising that these principles have substantial consequences for how current and linear supply chains are organised. This thesis deals with the question of how they can be organised differently, in order to be in accordance with the principles of a circular economy.

When studying the principles of a circular economy a first conclusion that can be drawn is that companies in the value chain must manage entire 'product value cycles', instead of contemporary product lifecycles. Apart from traditional value creation (i.e. the manufacturing of products), a product value cycle comprises the preservation, exploitation and restoration of product embodied values. These activities are three key ingredients of circular business models. To live up to these standards, companies must look beyond their core business and collaborate with other companies. From such partnerships 'circular value chains' will emerge, enabling companies to offer their customers a much broader value proposition. Circular value chains consist of all consecutive parties and their activities (i.e. links) along a product's value cycle, that have combined, shared, exchanged and co-developed resources, with a substantial improvement of material utility. For these circular value chains to emerge, this thesis explored the organisational boundary conditions, the operational resources and the managerial capabilities. The findings are summarized below.

Organisational boundary conditions

The organisational boundary conditions are those conditions that partners must conform to before progression towards circularity is made. First, partners must have developed a joint identity, which in essence states what they have in common. Amongst others, this can be a brand, a shared set of norms and values, a shared vision or shared objectives. If a partnership fails to develop a joint identity, it risks falling apart. Second, a circular value chain requires the interest, support and commitment from all parties. Without it, the partnership becomes fragile and will hardly make progress. Third, sufficient safeguards against failure and opportunism need to be installed. These can either rely upon formal agreements or upon trust. The absence of formal agreements is not advisable, but it is best to focus on trust. Fourth, a culture of transparency is required, so information can become shared and new trust is built. Fifth, partners will need to create an organisational structure that fits their philosophy best. A structure aimed at collaboration is built upon collective ownership, democratic decision-making, and a fair distribution of value. Finally, the partnership must not lose sight of the customer. Customer satisfaction is an integral part of a circular economy, and without it the partnership becomes non-existent.

Operational resources

The operational resources are the assets required that support the implementation of circularity throughout the value chain. The first of these are the circularity enabling technologies. These include a new wave of engineering and digital technologies. Engineering technologies enable material loops to be closed and supply renewable sources. Digital technologies enhance the relationships among partners, and those with their customers. They also make the management of a circular value chain easier. Value chains will become 'virtual', where all its constituents (people, computers, machinery,

resources, components, products, and other assets) become connected over the internet. With a proper measurement system in place, managers are guided to make the right choices for circularity. It consists of the tools and indicators that can determine the value chain's circularity performance. Of course, a circular value chain is dependent on an appropriate staff. Important competences and characteristics of them are an entrepreneurial attitude, being open-minded, creative and visionary. Finally, the speed of progress depends on the amount of financial resources. In general, partnerships have greater opportunities to finance innovation.

Managerial capabilities

The managerial capabilities ensure that all other resources become utilized to their full potential. They comprise collaboration, coordination, integration and stabilization. Collaboration occurs when partners can define explicitly what extra value is created by working together, and simultaneously have found a way to distribute this value. The latter requires a good coordination capability of the financial flow. Here, partners can either choose for an 'outside-in' method of being financially independent, so partners can determine their prices and margins by themselves, or they can choose for an 'inside-out' method, creating an allocation procedure so that the total profit at the end of the value chain is collected and distributed accordingly. This latter approach requires open-book accounting. Apart from a well coordination of the financial flow, the material flow needs to be coordinated properly. This implies avoiding material to be lost in processes like energy recovery or landfilling. Finally, the information flow needs to be coordinated properly so innovation can take place. This means that information must become shared with all participants, instead of it being shared with the adjacent suppliers and customers. With respect to integration, it is of vital importance that it takes place between the areas of repair, remanufacturing and recycling. The parties in these areas need to unite as one, with the primary aim of restoring the product embodied values with as little value destruction as possible (i.e. the inertia principle). Last but not least, the managerial capability of stabilization refers to a partnership's ability to absorb new information, to adapt, and its resilience and robustness to disruptions.

It is recommended that partners in the value chain first check their compliance with the boundary conditions, before they look for any missing operational resources. Finally, managerial capabilities are always important to take into account.

Glossary

A linear economy: an economic model of production and consumption in which resources are extracted from nature, manufactured into products, and disposed of in the form of waste. It presumes an infinite possibility of natural resource extraction and an infinite capacity of processing waste by the earth.

A circular economy: an alternative model of production and consumption to that of the linear economy, in which resources, materials and products keep circulating within the economy, which consequently becomes less dependent on primary resources and designs out waste.

Product-embodied value: a product fulfils a function and thereby provides customer value. This value is thus embodied in the product, and can be determined by looking at a product's shape and configuration of materials. The value increases in proportion to the complexity of this configuration.

Circular value creation: Apart from delaying emotional obsolescence, major determinants of circular value creation are the preservation, exploitation and restoration of product-embodied values.

Emotional obsolescence: the process of a customer no longer feeling attachment to a product, resulting in a decline of its usage, and eventually in the disposal or return to the provider.

Functional obsolescence: the process of a product losing its intended function, while maintaining a customer's desire to make use of the product.

Product value cycle: a concept referring to the origins of, and logic behind circular value creation. It comprises the creation, preservation, exploitation and restoration of a product's embodied value, combined with a strategy to delay emotional obsolescence.

Circular value chain: a chain of consecutive parties and their activities (i.e. links) along a product's value cycle, who combine, share, exchange and co-develop resources for a substantial improvement of their material utilization.

Value cycle: a more holistic and integrated approach to that of the circular value chain, where all its constituents have become part of a single organisational system aimed to keep the embodied value of its circulating products as high as possible.

Organisational resources: all constituents that make up an organisation, ranging from tangible assets (e.g. machinery, offices) to intangible assets (e.g. an organisation's reputation or access to the market).

Organisational capabilities: a special type of resource, functioning to increase the utility of all other resources residing in the organisation.

Collaborative advantage: a common benefit accrued to a group of parties through the combination, exchange, and co-development of idiosyncratic resources.

Product-service model: a mix of tangible products and intangible services designed and combined to increase customer value.

1. Introduction

1.1 Societal problem

From the start of the industrial revolution mankind has adopted a linear model of production and consumption; natural resources are extracted, manufactured into products, used, and finally disposed of, ultimately forming waste. This 'take, make, use and dispose' pattern puts enormous pressure on the environment, as resource stocks are being depleted and waste streams are increasing (Gregson, Crang, Fuller, & Holmes, 2015; Murray, Skene, & Haynes, 2015). Because resources are becoming increasingly scarce, companies begin to face serious problems in the supply of materials, intensifying competition between them and squeezing their profits. A study of the Ellen MacArthur Foundation (2013a) reveals that resource prices are on the rise and have become a lot more volatile. So, in addition to the environmental impacts, the well-functioning of the economic system is under threat. Due to several reasons these problems are likely to get worse than better. By 2030, it is expected that three billion people will have joined the ranks of middle-class consumers (McKinsey Global Institute, 2011), increasing the demand for natural resources even more. All taken together, the 'take-make-use-dispose' model causes a major societal problem and doing business in line with it cannot be sustained indefinitely.

In answer to these serious challenges people have started to think about an alternative way of production and consumption, that of a 'circular economy'. It draws upon and encompasses principles from different schools of thought, described briefly in Appendix A. In the late 1970s the first ideas were being developed (Ellen MacArthur Foundation, n.d.a), but not until 2012 it received as much attention as it is given today. In that year, the idea of a circular economy has been revitalized by the Ellen MacArthur Foundation when it published the first of a series of macroeconomic reports, quantifying the economic opportunities and laying out pathways for action. It has been estimated that for each year in the European Union alone, 630 billion euros can be saved when manufacturing industries adopt a circular model. Worldwide, by 2030, the economic gain has even been estimated to be 4,5 trillion dollar (Lacy & Rutqvist, 2015). Leading businesses and government agencies in various part of the world have now begun to implement a circular model in their own operations and activities (Ellen MacArthur Foundation, 2013a).

1.1 Research problem

Despite the enormous opportunities, many institutional, financial, technological, organisational and societal obstacles remain to be solved (Hassini, Surti & Searcy, 2012; IMSA Amsterdam, 2013; Schoolderman et al., 2013). See Appendix B for a brief overview of those. Many of the organisational obstacles reside in the current organisation of supply chains. For instance, there is a lack of an information exchange system and confidentiality and trust issues are hampering the exchange of information. Another issue raised is the question of who should be in control of the supply chain. There seems to be a lack of an oversight agency that controls it. Additionally, a lack of transparency is impeding cooperation. These issues lead to a limited experimentation of new business models. Despite the fact that existing reports have revealed fundamental obstacles in the organisation of supply chains, hardly do they propose organisational formats that tackle them. Apart from that, the Ellen MacArthur Foundation (2014) and others (e.g. Schoolderman et al., 2013) consider supply chains to be key in moving the circular economy forward. As such, supply chains are also considered to be the main research unit of this thesis.

The scientific community has also taken an interest in studying the circular economy phenomenon. Mostly in China this has occurred (e.g. Yuan, et al., 2006; Yong, 2007; Shao-Ping & Yun-Jie, 2010; Su et al., 2013), likely because of the strong embeddedness of the model in its national laws and education systems. As of 2013, new articles by scientists have also appeared in Western countries (e.g. Tukker, 2013; Genovese et al., 2015; Gregson et al., 2015; Murray et al., 2015). It can be expected that this trend of scientific interest continues to grow, because of its increasing popularity in some parts of the world. In the Netherlands for instance, a number of reports have been written on this topic (e.g. IMSA

Amsterdam, 2013; Bastein, et al. 2013; Schoolderman, et al 2014; De Groene Zaak, 2015) and this country claims to be a 'circular hotspot' (Circle Economy, n.d.). Although science has made a good contribution to the study of the phenomenon, and elaborates well on its principles, little guidance is provided on how supply chains can be transformed into circular systems.

1.3 Research objective

This thesis contributes to filling in the knowledge gap, by identifying the organisational boundary conditions, operational resources, and managerial capabilities necessary for the implementation of circularity in today's supply chains. This research is directed to answer the following main research question:

*How can a supply chain be organised, operated and managed
in line with the principles of a circular economy?*

Deliberately, the nature of this research question is quite broad and explorative, because the existing research on the circular economy concept is still in its early days (Murray et al., 2015). A blueprint of a circular economy still needs to be invented (IMSA Amsterdam, 2013). Also, take notice how the use of the term 'the circular economy' is avoided throughout this thesis and replaced by 'a circular economy'. There is only one economy and theoretically it may be just as well be a linear, inclusive, bio-based, sharing or other type of economy, depending on the chosen perspective. The research is embedded in the wider context of organisational studies which examines how individuals construct organisational structures, processes and routines and how these, in turn, shape social relations and create institutions (Clegg & Bailey, 2007).

To make the research question more concrete, three sub questions have been formulated:

- To which **organisational boundary conditions** must a new circular system conform, before progress can be made?
- What **operational resources** are required that support the transformation from a linear supply chain to a circular system?
- What **managerial capabilities** are required to make the transformation succeed?

These questions are answered based on the creation of a theoretical framework, whereby its elements cover the research questions above. Input for this framework has been provided by a variety of research fields, such as traditional and sustainable supply chain management, operations management and information management. Before this framework is shown, a better understanding is required about the principles of a circular economy and how these fit in the definition of 'circular business models'. This way, it becomes clear what is meant by "*in line with the principles of a circular economy*", as quoted from the main research question.

2. Theory

2.1 Circular economy principles

A circular economy is sometimes looked upon as an economic model maximizing human well-being (Murray et al., 2015). As with most approaches which are perceived as sustainable, this is a valid point, but including this aspect as part of its core definition would make it too comprehensive for its purpose. It might be better to focus on just the environmental and economic dimensions and leave the social dimension to the notion of sustainability. In line with this reasoning a circular economy refers to “*an industrial economy that is restorative by intention; aims to rely on renewable energy; minimizes, tracks, and eliminates the use of toxic chemicals; and eradicates waste through careful design*” (Ellen MacArthur Foundation, 2013a, p. 22). It makes a sharp distinction between the consumption of ‘biological nutrients’ and the use of ‘technological nutrients’. Biological nutrients are designed to safely re-enter the biosphere and can therefore be consumed. Technical man-made nutrients, like plastics and metals, are designed to circulate at a high grade of quality without entering the biosphere (McDonough & Braungart, 2010). A circular economy further advocates a ‘performance-based’ model in which manufacturers and retailers retain ownership of the products and act as service providers (Stahel, 2010). This will lead to innovation in business models that generate more durable products, facilitate disassembly and remanufacturing. It will also result in the creation of take-back systems and reverse logistics. Underlying a circular economy, there are three core principles to adhere to (Ellen MacArthur Foundation, 2015a):

1. **Preserve and enhance natural capital** by controlling finite stocks and balancing renewable resource flows
2. **Optimize resource yields** by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.
3. **Foster system effectiveness** by revealing and designing out negative externalities.

A visual representation of the circular economy is shown in Figure 1.

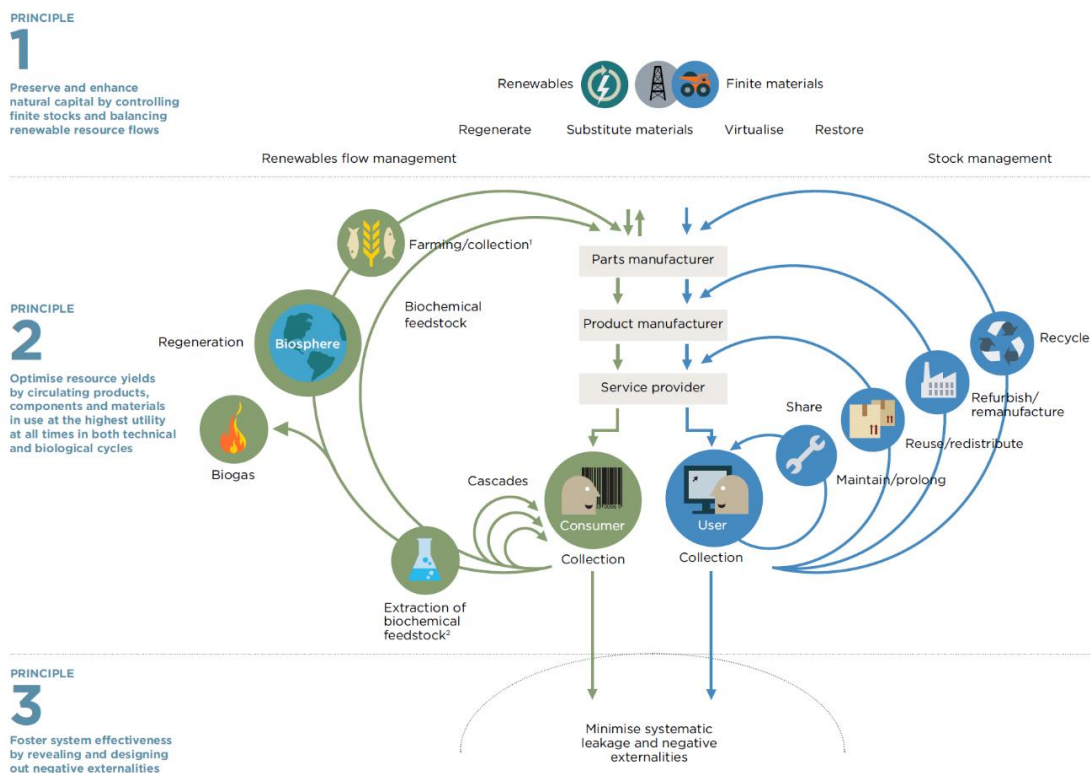
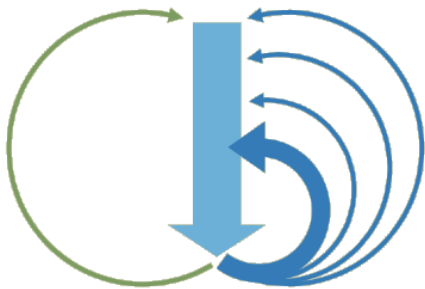


Figure 1: The circular economy systems diagram. It illustrates the continuous flow of biological and technical materials in the economy (Ellen MacArthur Foundation, 2015a)

As can be seen from the figure, biological and technical nutrients flow through a variety of so-called 'value circles'. Here, four sources of value creation can be identified: 'the power of the inner circle', 'the power of circling longer', 'the power of cascading use' and 'the power of pure circles' (Ellen MacArthur Foundation, 2012). They will be explained briefly.

I) The power of the inner circle:

The tighter the circle, the larger the savings on material, labour, energy, capital and the smaller the impact on the environment.



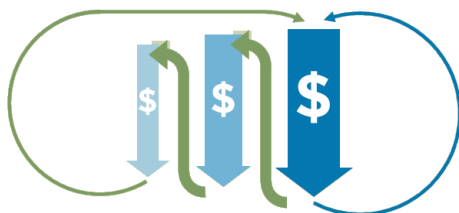
II) The power of circling longer:

Value is created and preserved when products, components and materials go through consecutive cycles or spend more time within a circle.



III) The power of cascading use

This stands for the cascading of products, components and materials across different product categories.



IV) The power of pure circles

Products and components are designed to be pure in material use and non-toxic. This makes them easier to separate once they reach the end of a lifecycle.



The figures are from the Ellen MacArthur Foundation (2013a)

The power of the inner circle is better known as the inertia principle, introduced by Walter Stahel. For many people he is considered to be the founder of the circular economy concept. The inertia principle implies a prioritization of restoration activities, as seen in Figure 2. Restoration is the set of actions to a partially damaged or lost object with the aim of bringing it back to a predefined state.

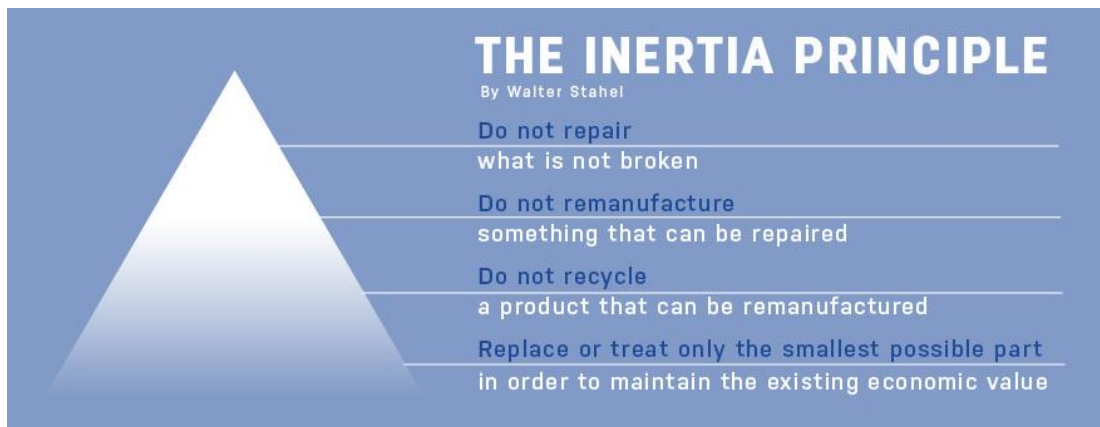


Figure 2: The inertia principle (CircularX MOOC, 2015)

2.2 Redefining the supply chain

Traditional supply chain management is hardly concerned with circularity (Ying & Li-jun, 2012). It is merely concerned with parties that deal with resource extraction, manufacturing, distribution and retail. In sustainable supply chain management, the chain is sometimes extended by including the final customers and those parties in the take-back chain (i.e. the repair, remanufacture, refurbishment, and recycling). Such activities are studied more extensively in the research field of reverse logistics. In a circular economy both parts of the chain need to get linked to one another. This is referred to as 'closing the loop' (Zhu, Sarkis, & Lai, 2008). When various authors made a connection between the supply chain concept and closing material loops, they added a recovery component to the term, such as 'Closed-Loop Supply Chain' (Matos & Hall, 2007; Seuring, Sarkis, Müller, & Rao, 2008; Zhu et al., 2008) or 'Reverse Supply Chain' (Genovese et al., 2015; Linton, Klassen, & Jayaraman, 2007; Sheu, 2014). The supply chain and take-back chain are in essence a myriad of value activities, illustrated in Figure 3. They can therefore also be looked upon from a 'value chain' point of view. This may bring some confusion to those who are familiar with the concept of the value chain as how it was first introduced by Porter (1985). He used the term to describe the various business activities within a single company to create a competitive advantage and thus it did not exceed a company's boundaries. This idea was brought to life in a time when management scholars focused on the internal processes of a company to gain a competitive advantage (Wernerfelt, 1984; Prahalad and Hamel, 1990; Barney, 1991). In later years, individual businesses recognized that they no longer compete as solely autonomous entities, but rather as supply chains (Lambert & Cooper, 2000). Instead of seeking an individual competitive advantage, managers aimed at a collaborative advantage, which is "a common benefit accrued to collaborative partners through the combination, exchange, and co-development of idiosyncratic resources" (Cao & Zhang, 2011, p. 164). It can be looked upon as a joint competitive advantage and focuses on joint value creation. Businesses that have



Figure 3: Links of a circular value chain (adapted from Plan C, n.d.)

managed to close the loop have found an additional way of creating value (i.e. creating a resource from former waste). However, 'circularity' goes beyond closing material loops, i.e. recycling (Ellen MacArthur Foundation, 2012). The precise meaning will be dealt with in the next section on circular business models.

2.2 Circular business models

A business model is in essence a representation of the underlying logic and the strategic choices of an organisation to create and capture value (Shafer, Smith, & Linder, 2005). It defines the manner by which an organisation delivers value to customers, entices customers to pay for that value and converts those payments to a profit (Teece, 2010). Traditional business models are not fit for circularity, because they externalize costs to the environment or society at large (Jonker, Tap & Straaten, 2013). Instead, 'circular business models' are necessary to address those issues. In this section, the underlying logic of these business models is explored.

2.2.1 Circular value creation

Different types of value are created by companies, from more materialistic values (e.g. goods) to more nonmaterialistic values (e.g. care, safety, fun, insurance) (Jonker, 2013). Companies involved in the production of physical goods create customer value by the products they design, manufacture and deliver. This type of value is thus embodied in the product, hereafter called 'product-embodied value'. See Figure 4 for an example.

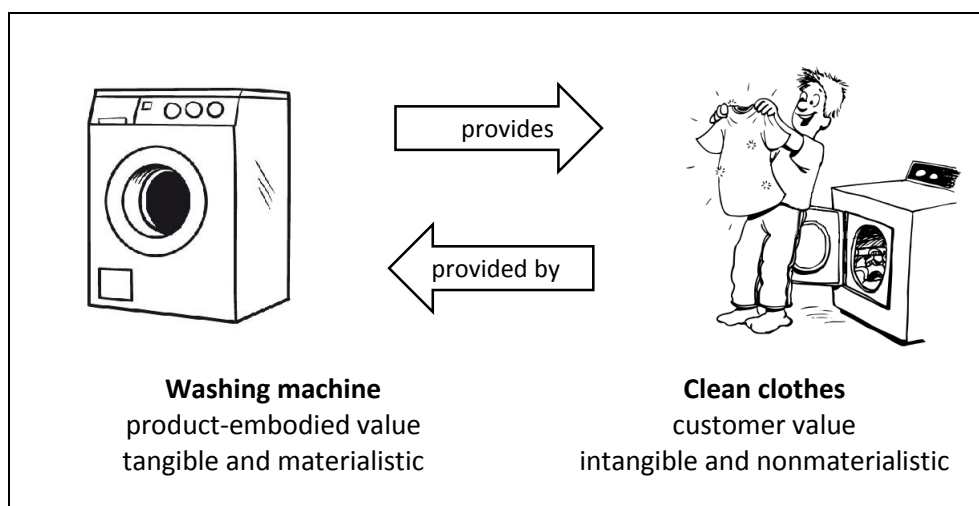


Figure 4: The relationship between a product and its derived customer value

As can be seen, the product-embodied value and the customer value are in a symbiotic relationship with one another. The product would not exist if there was no customer value to fulfil and the customer value would not exist if there was no product.

In comparison to customer value, it is important to distinguish the product-embodied value as a materialistic value. It is also an intrinsic value, assuming that products have some sort of reason or right to exist. Industrial designers refer to this as the product's integrity (Bakker, Hollander, van Hinte & Zijlstra, 2014). Clark (1989) observed that products gain integrity depending on how well the concept behind the product satisfies potential customer's wants and needs, and how this concept has been embodied in the product's details. In essence, he described both the potential derived customer value, as well as the product-embodied value.

The product-embodied value refers to an estimation of the input required to create a product. Determining the value can be done in many ways, for instance by looking at the amount of energy or labour that has been put into the production process, or by simply looking at the final price. It may

however be best to look at the product's details themselves, as Clark (1989) has put it. This aligns the definition of product-embodied value with the product's appearance. It is a function of the product's shape and configuration of materials. For many of the goods this configuration becomes increasingly complex, thus resulting in a higher value. More materials are required and material relationships become increasingly complicated. An electronic device for instance consists of many more materials and material connections in comparison to a wooden chair. This may be the reason why complex products are generally more expensive than simpler products. Anton Brummelhuis, senior director of sustainability at Philips once said: *"Often in the circular economy it is about which materials are being used, but more importantly is to look at the whole design (...) if you want to sell your car after ten years, the car is worth more than the value of its loose components added together"*. It has further been estimated the value of raw materials used in a computer with a sales price of €1.100, is only € 8.50. (Hieminga, 2015). Most of the value is thus stored in the complexity of the products, rather than the raw materials. It shows how the value of a product is determined by the shape and configuration of its materials. The act of recycling, which brings the product back to its raw materials, will therefore only recover a small fraction of the value.

The product-embodied value increases over time when the product goes through consecutive value chain activities, such as the production of raw materials and components, or the process of assembly. This is pictured in Figure 5.

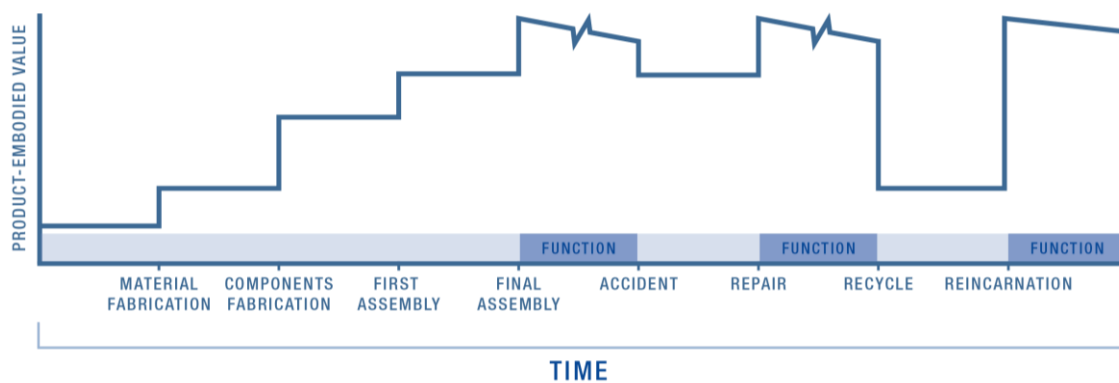





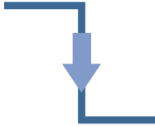

Figure 5: The lifecycle of a random product and its relation to the product-embodied value

The graph starts with the fabrication of raw materials from nature. In a circular economy however, companies will look for substitutes of virgin resources as main input for their products. The main reason for this is that recycled raw materials hold a greater product-embodied value than their origins from nature (e.g. rocks, ores, plants, trees). Recycled raw materials are, in theory, pure in material composition. After the fabrication of raw materials, components are fabricated and assembled into a final product. In these steps, the product-embodied value increases, because the materials are being shaped into their final configuration. The moment of final assembly is a tipping point in the value chain, because at that moment the configuration of contained materials is set up in such a way that the product receives its intended function. From that moment, the product can be sold, rented, leased or it can provide a service. After an indefinite period of usage, the product-embodied value has decreased a little due to wear. Some fraction of material is lost or displaced, increasing the probability that the product will malfunction. Maintenance and careful use will delay this process. Inevitably, at a particular moment the product loses its functionality, after which the restoration of its embodied value follows. This means repair, remanufacturing, refurbishment or recycling, depending on the needs and circumstances of the producer, the user and the market. During this period, the product is in a state of dysfunction, which companies want to keep as short as possible. Conversely, they want to upkeep the time the product is functioning. Lacy & Rutqvist (2015) have put it as follows: *"Companies in a circular*

economy are primarily focused on value creation based on managing resources in the markets, as opposed to managing resources solely in production” (p. 5).

If we zoom further into the graph, we can distinguish five types of ‘value activities’, four of which have a positive, and one a negative influence on the product-embodied value. They are related to various value chain activities or other (natural) causes, as listed in Table 1. Additionally, products can be designed in such a way that they support one or more of those activities. These design strategies are also included in the table.

Table 1: Five types of value activities and their associated value chain processes and design strategies

Value creation (+)	Value preservation (+) (preserve the value that has been created)	Value exploitation (+) (exploit the value that has been created)	Value destruction (-)	Value restoration (+) (restore the value that has been lost)
				
Related value chain processes or other causes:				
<ul style="list-style-type: none"> • Production of raw materials • Assembly 	<ul style="list-style-type: none"> • Maintenance • Careful use 	<ul style="list-style-type: none"> • Long-lasting use • Re-use • Co-use 	<ul style="list-style-type: none"> • Wear • Accident • Recycle • Market-entry of a replacement 	<ul style="list-style-type: none"> • Repair • Refurbish • Remanufacture • Reincarnate
Related circular design strategies, inspired by Bakker et al. (2014):				
<ul style="list-style-type: none"> • Design for customer value 	<ul style="list-style-type: none"> • Design for durability • Design for ease of maintenance 	<ul style="list-style-type: none"> • Design for attachment and trust • Design for upgradability and adaptability • Design for standardization and compatibility 	<ul style="list-style-type: none"> • Design for planned obsolescence¹ • Design for disassembly 	<ul style="list-style-type: none"> • Design for repair • Design for reassembly • Design for reincarnation

The preservation, exploitation and restoration of product-embodied values are three key ingredients of circular business models. For linguistic purposes these three forms constitute the terminology of ‘circular value creation’.

Having explained product-embodied value, a closer look at a product’s derived customer value needs be taken to fully understand circular value creation. In a circular economy, businesses will question themselves what customer value they create with the products they make. Customer value is an intangible value, providing a real challenge for companies to identify. They need to ask themselves what the product enables their customers to do and can be looked upon as the service that it brings along. For instance, a car enables customers to travel, but also provides shelter or the ability to enjoy music in comparison to a bicycle. For most of the goods the derived customer value decreases in the course of time. The goods will eventually become ‘obsolete’. It occurs when the customer no longer feels his desire for the product. For instance, a customer who owns a computer for more than a few years will yearn for a new computer when it does not fulfil his requirements anymore or when it becomes incompatible with its environment (e.g. as a result of new software). When a product is no

¹ Planned obsolescence is a strategy of designing a product with an artificially limited lifetime. This generates long-term sales for producers by means of reducing the time between repeated purchases (Economist, 2009). It is a fundamental design strategy in the linear economy.

longer desired, yet remaining its functionality, the product becomes ‘emotionally obsolete’ and has therefore, from an economic point of view, reached the end of its lifetime. Emotional obsolescence can be caused by innovation, marketing, fashion or other trends. When a product actually stops functioning and reaches its technical lifetime, it has become ‘functionally obsolete’. This can either be caused by planned obsolescence, wear or an accident. In the table below two examples are provided.

Functional obsolescence:	Emotional obsolescence:
The printer someone always enjoyed using, suddenly breaks down.	Someone considers replacing his current smartphone with a newer version.
Economic lifetime exceeds technical lifetime.	Technical lifetime exceeds economic lifetime.

Emotional obsolescence will put pressure on the product-embodied value; a drop in the experienced customer value will eventually result in losing this value. In a circular economy, it is therefore one of a company’s goals to delay emotional obsolescence, as part of circular value creation. Walter Stahel (1997) phrased it as one of a circular economy’s main objectives to create the highest possible use value for the longest possible time. In practice, companies can achieve this by applying circular design strategies aimed at trust, attachment, upgradability and adaptability (Bakker, Hollander, van Hinte & Zijlstra, 2014). To summarize, circular business models are designed to create, preserve, exploit and restore the embodied value of products. At the same time, they are designed to extend the period in which customer value is experienced. This constitutes the ‘product value cycle’, visualised in Figure 6.

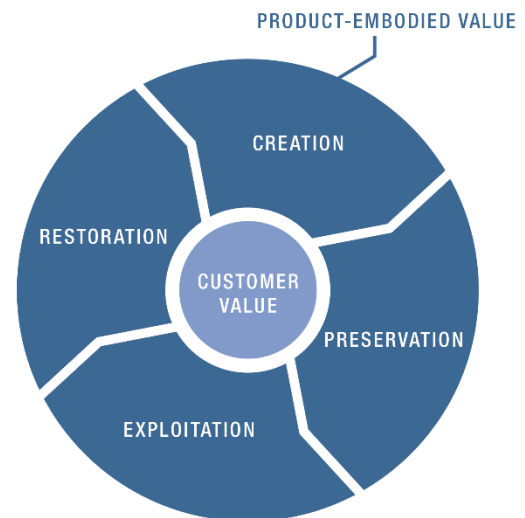


Figure 6: The product value cycle

A truly circular business model is built upon the entire product value cycle, not just part of it. However, if we compare this assumption to the current landscape of businesses we can, not surprisingly, find many inconsistencies. The majority of companies still behave linearly; not having anything to do with value preservation, exploitation or restoration. Subsequently, an increasing base of companies do so as an extension to their core business. Finally, a negligible amount of companies have a business model exclusively focused on circular value creation. Capturing the entirety of potential value of a circular economy requires collaboration between these companies to, ultimately, manage all product value cycles. The necessity of collaboration will be further discussed in the section about the resources and capabilities of the circular value chain. As a result, the theoretical basis of this thesis will become clearer, but not before some attention has been paid to circular value capturing. After all, value creation, preservation, exploitation and restoration may seem the logic behind circular business models, this is only true when companies have found a way to capture this value.

2.2.2 Circular value capturing

Companies have found several ways to capture circular value with innovative revenue models as part of product-service systems. A product-service model consists of a mix of tangible products and intangible services designed and combined to increase customer value (Peruzzini, Germani, & Marilungo, 2013). The model calls for the idea of an 'extended product' by incorporating intangible services. Three product-service models can be distinguished, depending on their focus on either the product, the service, or a combination of those elements. They are product-oriented, use-oriented and result-oriented models, as shown in Figure 7.

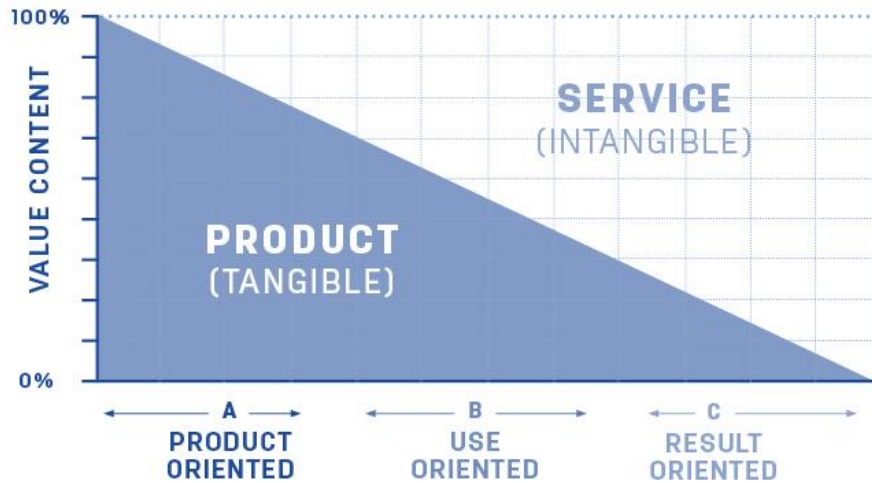


Figure 7: The spectrum of product-service models (CircularX MOOC, 2015)

Product-oriented models are currently the most dominant in the economy and are considered the most linear. They are geared towards the sales of products, although some extra services can be added, such as a maintenance contract and a warranty declaration. An example is the model of a company selling central heating systems with a warranty declaration, on the basis of a single transaction. In use-oriented models, the product still plays a central role, but it is owned by a provider and offered by granting access to a customer. This enables the provider benefiting from product endurance, instead of him benefiting from products that do not last (Bakker, Hollander, van Hinte & Zijlstra, 2014; Stahel, 2010). Planned obsolescence is eliminated and it becomes profitable to invest in the complete product value cycle. Maintenance, repair, upgrading, and eventually recycling become all part of the deal and for every measure taken to increase resource utilization, a company will be financially rewarded. Here, the drivers for reducing resource consumption have not been incrementally improved, but are radically transformed. Referring to the central heating systems, customers can now lease their products, instead of buying them. In addition to capturing circular value by means of customer payments, it also derives from savings on material costs, since the provider of the service retains ownership of the product. Finally, companies which offer their customers to pay purely for well-defined customer value have a result-oriented business model (Cook, 2004). In this case, the company and its customers agree upon a particular result and a pre-determined product is no longer involved. Recalling the example of the central heating systems, the customer may now buy comfortable heating instead of buying the product that generates this heat. At any time, the product can be replaced by another one, without any consequences for the customer. The heating systems may now be replaced by a heating pump for instance. In a circular economy, result-oriented business models become increasingly important, because companies will question themselves how they can deliver the same customer value with the least amount of resources. In Figure 8, all the types of product-service models are shown, along with

pure product models and pure service models, in which a car is the product and transportation the service.

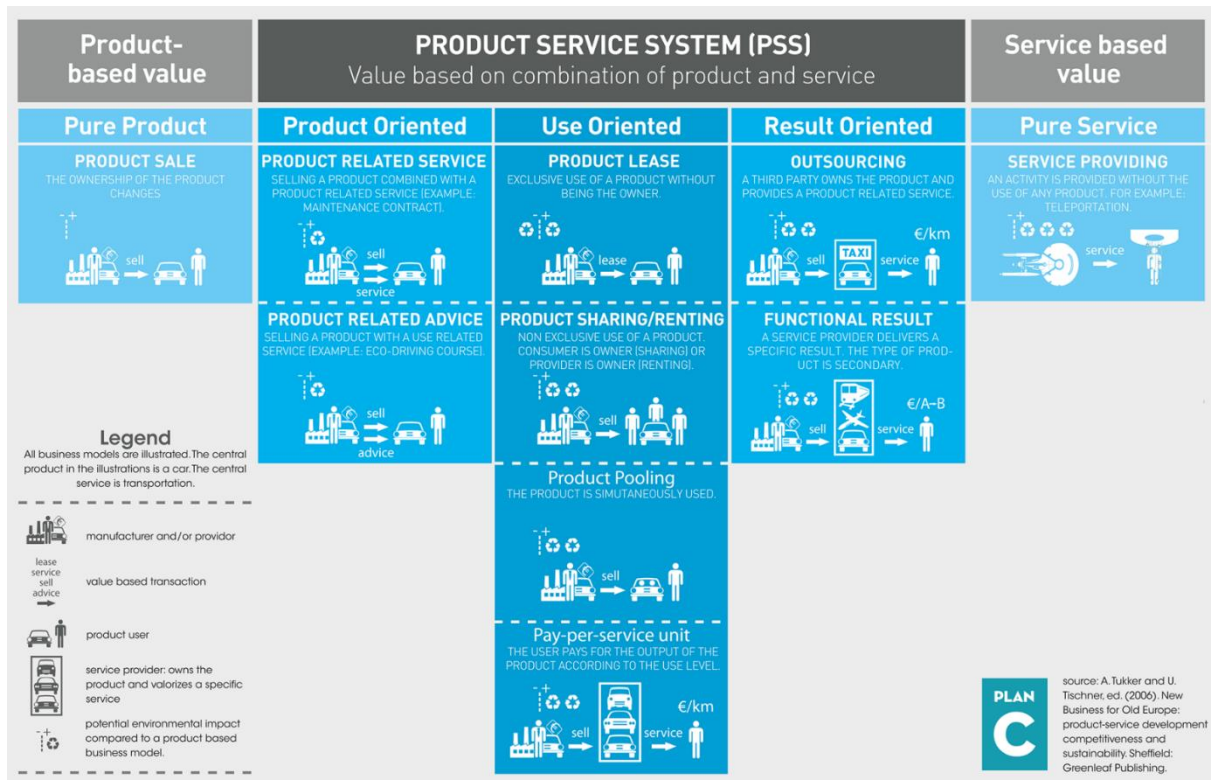


Figure 8: The various types of product-service systems (Plan C, n.d.)

In pure product-based models no services are provided and in a pure service-based models the service is offered without the use of a conventional physical product. The process of replacing a physical product with a digital alternative is called dematerialization (Cogoy, 2004; Lacy & Rutqvist, 2015). Due to ever advancing digital technologies many products are becoming obsolete, such as books being replaced by e-books, or CD's by music streaming services like Spotify. A good understanding must now have been provided of what circular business models are. In the following section this will be related to the circular value chain, by looking at its resources and capabilities.

2.3 Resources and capabilities of the circular value chain

In any organisation resources are vital (Wernerfelt, 1984; Barney, 1991) and the management of an organisation is the function that coordinates the efforts of people to accomplish certain objectives with the use of available resources (BusinessDictionary, n.d.). Resources can be tangible (e.g. machinery, land, production facilities, offices) and intangible (e.g. reputation, intellectual property, procedures), but having resources alone is of little value. Only if the company possesses particular capabilities, it will be able to deploy and improve the productivity of the resources (Makadok, 2001). The capabilities of the value chain are the ability to identify, utilize, and assimilate the resources residing in the value chain to facilitate its activities (Wu, Yenyurt, Kim, & Cavusgil, 2006). In turn, dynamic capabilities are the organisation's ability to build, integrate and reconfigure resources to deal with rapidly-changing environments (Teece et al., 1997). The critical depletion of natural resources and the increase and volatility of resource prices can be considered as such a rapidly-changing environment. Companies are forced to organise themselves in a new way, one that is resilient to the scarcity of resources. They have to acquaint themselves with managing all their product value cycles. However, most companies will lack the resources for this, so they collaborate with other organisations to exchange the missing resources. Other companies may possess the missing resources, avoiding companies to build them by themselves and avoiding them to reinvent the wheel. Therefore, it has become clear that an inter-organisational perspective is fundamental for organising a circular economy. Those companies that look beyond their own organisational boundaries and those that form partnerships are considered more future-proof. Lacy & Rutqvist (2015) have put it as follows: *"Companies have to think beyond the traditional core and build an ecosystem of partners that operate and monetize the entire product lifecycle [sic]"* (p. 149). In this quotation, the product lifecycle will have to be replaced by the product value cycle (Figure 5), because the lifecycle can no longer be taken for granted, but as something that can be influenced, adapted or extended.

Once companies have formed such a partnership, the collaboration itself can be seen as a new organisational entity with its own resources and capabilities, as pictured in Figure 9. The research on inter-organisational resources and capabilities has grown lately, but is still limited to the field of traditional supply chain management (Institute for Supply Management, 2014). Similarly to Esper & Crook's (2014) observation that resources not only within, but also across the boundaries of a company are vital for understanding supply chain management, they are also relevant for understanding circular value chain management. This idea forms the theoretical basis for answering the main research question of how a circular value chain is organised, operated, and managed, by identifying its inter-organisational resources and capabilities.

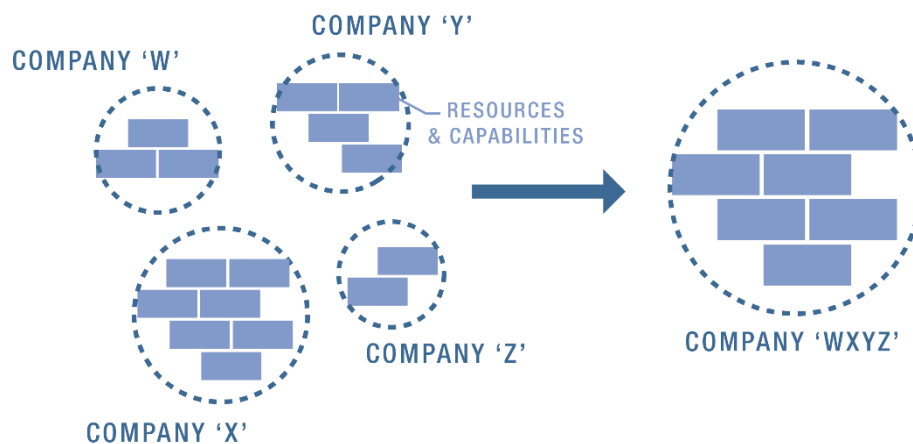


Figure 9: Extending the theoretical scope of resources and capabilities to an inter-organisational level

Therefore, a theoretical framework for organising, operating and managing a circular value chain consists of the inter-organisational resources and capabilities required for circularity. It comprises three domains. The first domain deals with the intangible resources perceived as organisational boundary conditions, which the system must conform to before substantial progress can be made. The second domain consists of the more tangible and operational resources, which enable and support the transformation towards a circular value chain. The third and last domain consists of the managerial capabilities which are required to make effective use of the other resources. These will make the transformation to circularity succeed. Circular value chain management is thus about building the proper boundary conditions and makes use of the available resources with the help of capabilities, all with the objective of circularity in mind. In Figure 10, the overview of the framework is shown, after which each element will be explained.

<div><div>ORGANISATIONAL BOUNDARY CONDITIONS</div><div><div><ul style="list-style-type: none">Joint identityParties' self-interest, support and commitment</div><div><ul style="list-style-type: none">Safeguards against failure and opportunismTransparency</div><div><ul style="list-style-type: none">Collaborative structureSatisfaction of customer demands</div></div></div>	<div><div>MANAGERIAL CAPABILITIES</div><div><ul style="list-style-type: none">CollaborationCoordinationIntegrationStabilization</div></div>
<div><div>OPERATIONAL RESOURCES</div><div><div><ul style="list-style-type: none">Circularity enabling technologiesCircularity measurement system</div><div><ul style="list-style-type: none">Appropriate staffFinancial resources</div></div></div>	

Figure 10: The inter-organisational resources and capabilities of a circular value chain

2.5 Organisational boundary conditions

- | | | |
|--|--|------------------------------------|
| • Joint identity | • Safeguards against failure and opportunism | • Collaborative structure |
| • Parties' self-interest, support and commitment | • Transparency | • Satisfaction of customer demands |

2.5.1 Joint identity

An organisation will only survive if management recognizes the importance of a cultural identity (Carrillo & Gromb, 2007). This can be derived from a brand, core competences, a core product portfolio, a shared vision, shared objectives, shared interests, shared codes of conduct or shared norms and values (Choy, Lee, & Lo, 2003a, 2003b; Lee, 2015; Li & Lin, 2006; Manthou, Vlachopoulou, & Folinas, 2004; Prahalad & Hamel, 2006; Sahay, 2003; Jonker et al., 2013). A shared vision will give guidance and a direction for progress (Li & Lin, 2006). It will also signify the reason why collaboration is essential (Jonker et al., 2013). The more these aspects exist in a partnership, the stronger the joint identity will be and the higher the chance the entire organisation will not fall apart. A joint identity can be made tangible by making it formal (e.g. putting it on paper, a website or another type of communication channel). This formalisation needs to be done in such a way in that everybody is heard (Boyd, Spekman, Kamauff, & Werhane, 2007). This avoids preliminary misalignment between parties and will help them to identify themselves with the main objective of the partnership. Once the joint identity has been institutionalised, a further expansion of a partnership will endanger the joint identity, for new parties have their own interests and objectives and are not familiar with those of the partnership (Carrillo & Gromb, 2007; Jaber & Goyal, 2008; Power, 2005). Managers are therefore advised to put an effort in aligning the interests and objectives of the various participating parties (Cao & Zhang, 2011). How this can be achieved is explained in the next section on self-interest, support and commitment.

2.5.2 Parties' interest, support and commitment

Collaboration only succeeds when parties connect in a meaningful process which takes all interests into account (Jonker, 2013). The different interests residing in the value chain should therefore not be 'swept under the carpet'. Instead, partners should empathize themselves with their partners' interests, with respect and sincerity and come to solutions that are in the interest of all parties. Collaboration transcends the gratification of self-interest, but partners will not develop a long-term relationship if their self-interest is not sufficiently met. There has to be a balance of 'give and take'. That is why reciprocity is such an important concept in collaboration processes (Barratt, 2004). If an organisation is not capable of shaping a process based on reciprocity, partners will only pretend to collaborate. There will be a lot of talking, but it will hardly lead to tangible results (Jonker, 2013).

Apart from the partner's interest, intra-organisational support is required (Barratt, 2004). Intra-organisational support will determine the degree of process alignment and eventually contributes to the success of the collaboration. It consists of two distinct forms: the initial and ongoing support from top-management and the support from other parts of the organisation (e.g. purchasing, manufacturing, marketing and sales). Hitchcock & Willard (2008) emphasize that support from top management is essential for long-term success, but Barrat (2004) refers to the fact that support from other parts in the organisation is equally important. The demonstration of a viable business case is most important for gaining support from higher management, while displaying the results is most important for fostering support from the rest of the organisation.

Transforming the linear supply chain to a circular value chain requires new organisational structures. This invokes change and with change comes resistance (Fawcett, Fawcett, Watson, & Magnan, 2012; Lozano, 2013). This resistance manifests itself in a variety of behaviours (e.g. confusion, denial,

sabotage, silence, criticism, delay). People have a natural resistance to change, because they fear the unknown. They anticipate loss of status, pay or comfort. Resistance therefore has to be foreseen and neutralized prior to when it occurs. Different strategies will achieve this, which can be applied on different levels of the organisational system (i.e. individuals, groups and the organisation) and can target the informational, emotional or behavioural attitude. Because for many companies the initiative of building a circular value chain will come from an external party, participation is a crucial element in those strategies.

Lastly, commitment is key in developing an integration and collaboration capability and ensures tangible results are made. Without commitment, the relationships become fragile and vulnerable. It can be seen as the belief that an ongoing relationship is so important, to warrant maximum efforts for maintaining it (Kwon & Suh, 2005). This occurs when partners believe their relationship endures indefinitely. Many collaboration initiatives are resource intensive, meaning that partners must be prepared to exploit those resources (Barratt, 2004). It was further investigated that the presence of trust is an important determinant for the level of commitment (Dyer, 2002; Gold, Seuring, & Beske, 2010; Sahay, 2003).

2.5.3 Safeguards against failure or opportunism

In every partnership the possibility of failure and opportunistic behaviour exists, in which one partner takes advantage of weaknesses that other partners may have. It causes harm and is unhealthy for the longevity of the partnership (Fawcett et al., 2012). To minimize the chance of failure and opportunistic behaviour, particular safeguards need to be installed. Generally, two types of safeguards can be distinguished. The first type relies on formal agreements, often referred to as 'contracts', whereas the second type of safeguards is based on trust.

Declarations, the terms and conditions, cooperation-, non-disclosure- and exclusivity agreements are examples of the first type of safeguard. They have the objective of delineating the authority-responsibility structure and share risk among the partners (Ghosh & Fedorowicz, 2008). Contracts specify the obligations of every party and enable them to sanction any misbehaviour by other partners (Dyer, 2002).

Trust, which is essential in the second type of safeguard, can be defined as the confidence of one party that its vulnerability will not be exploited by other parties (Dyer & Singh, 1998). For partnering members of a value chain it plays a crucial role, because the relationships involve a high degree of inter-dependency (Kwon & Suh, 2005). In a transaction the presence of trust becomes increasingly important when uncertainty and asymmetric information grows, which refers to the situation when one party has more or better information than the other. Trust grows when parties communicate, interact and share past experiences, resulting in them becoming more acquainted (Akkermans, Bogerd, & Van Doremalen, 2004; Sahay, 2003; Wang, Zhao & Qu, 2012). During this process, uncertainty and information asymmetry declines; habits are formed and the behaviour becomes institutionalized, but it requires plain hard work (Akkermans et al., 2004). By repeatedly making promises and delivering upon them, partners will learn to rely upon each other. The interpretation and assessment of each other's motives, by means of open communication, is an appropriate way to increase trust. In multi-party settings it is transferable, from one person to another (Sahay, 2003). This occurs when partners have built a good reputation, so that it will become transferable between individuals. In the end, trust needs to become an inter-organisational resource shared by all members of the chain (Gold et al., 2010). This will be difficult to achieve, because for one, the distance between the provider and receiver of trust is increased, and for two, attention and care is divided among multiple parties (Buchan, Croson, & Dawes, n.d.). This may be the reason why one study revealed that when the number of parties in a partnership increases, managers must rely more often on formal agreements instead of on trust (García-Canal, Valdés-Llaneza, & Ariño, 2003). Formal agreements also tend to be more important in asymmetric bargaining power structures, since those parties with more power are able to exploit parties with less power (Ghosh & Fedorowicz, 2008). A final reason why

managers choose for formal agreements is that in the absence of those agreements, the damage caused by opportunistic behaviour is larger, since parties are not able to receive any compensation.

Managers can choose for either type of safeguard or a combination of the two. Both of them are not mutually exclusive, but instead are complementary to one another (Blomqvist, Hurmelinna, & Seppänen, 2005). It was found that contracts can increase the level of trust between partners (Ghosh & Fedorowicz, 2008). They set the ground rules for new relationships in the absence of pre-existing trust, or remind partners on agreed-upon conditions as time goes by. Building trust must therefore be seen as establishing an additional safeguard, besides using formal agreements alone. Since there are many parties involved in a circular value chain, it is wise to install some formal agreements on at least the most fundamental principles. As for the rest, managers are advised to avoid the use of many formal agreements, because it was found that they can be costly and have a diminishing effect on the opportunities of value creation (Dyer & Singh, 1998). Moreover, contracts have their own deficiencies and will not protect parties against all forms of opportunistic behaviour.

2.5.4 Transparency

Transparency is seen as openness or the willingness to share information. Transparency and information sharing are two sides of the same coin, but there is a slight difference. In contrast to information sharing, which is an active process, transparency can be seen as a passive component ingrained in the organisational culture (Barratt, 2004). Transparency therefore enables the activity of information sharing and is vital for the overall performance of a circular value chain (Schoolderman et al., 2014; Ellen MacArthur Foundation, 2013a). Transparency and information sharing develops trust (Kwon & Suh, 2005), because it reveals that partners have nothing to hide and information asymmetry is reduced. Conversely, transparency and information sharing also grows parallel to the levels of trust (Ghosh & Fedorowicz, 2008). They are therefore linked to trust in a self-reinforcing feedback loop (Akkermans et al., 2004), as shown in Figure 11. It has further been found that sharing confidential information is the best way to build trust, because the party is willing to make itself vulnerable, proving that he trusts the receiver with the knowledge he shares.

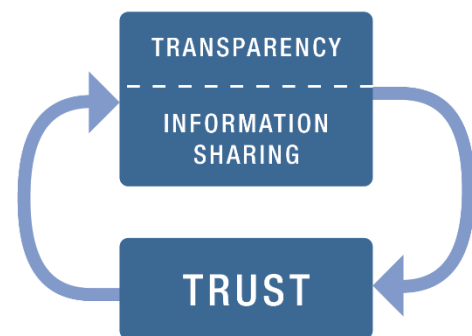


Figure 11: The relationship between transparency, information sharing and trust

2.5.5 Collaborative structure

Three characteristics regarding the organisational structure are found to be important to foster collaboration throughout the value chain. The first characteristic is collective ownership, to give parties a tangible stake in the entire business and to flatten asymmetric power relationships. In structures with power asymmetry one partner controls a set of resources which other channel members want and need, thereby acquiring bargaining power, enabling them to exert influence over others (Ghosh & Fedorowicz, 2008). It is detrimental to trust and subsequently to the performance of the value chain. This situation should therefore be avoided by giving parties access to all resources residing in the partnership. The 'access model' of a circular economy is therefore not exclusively intended for final customers, but is applicable to all parties within the chain. Participants can determine for themselves if resources are shared without payment or on a transactional basis. Of course, when they choose for the former power asymmetry will be reduced more than in the latter case. Collective ownership of the resources within the value chain will also increase a party's responsibility for the well-functioning of the entire organisation. Finally, the risks are distributed among multiple parties. Collective ownership can also be achieved by means of equity structures (Dyer & Singh, 1998). One of the most well-known equity structures is derived from the Japanese business culture and is called Keiretsu (Brouthers, Gao, & Napshin, 2014). It refers to a group of companies with interlocking business relationships and

shareholdings. In other words, each company in the partnership holds a share in his partners, so they become 'interlocked'. These keiretsu structures may also be applied to partnerships for circularity.

The second characteristic of a collaborative structure is the situation in which each party is able to influence decision-making (i.e. they have a 'voice' in it) (Boyd et al., 2007). Here, the legal entity of the cooperative deserves some special attention. Cooperatives work with a voluntary and open membership and with democratic member control (International Co-operative Alliance, n.d.). Democratic member control means that each party has a vote in a decision-making process. The proposals that gain the majority of votes will be adopted and implemented. Although it is evident that a certain type of democracy is required, there is still some discussion whether a hierarchical structure or flat structure will benefit the overall performance (Flynn, Huo, & Zhao, 2010; Patterson, Grimm, & Corsi, 2003; Saharidis, Kouikoglou, & Dallery, 2009; Sahin & Robinson, 2005). Traditional, functional or centralized structures are likely to impede the creation of collaboration capability (Fawcett et al., 2008), but do usually benefit coordination capability (Garcia Salcedo, Ibeas Hernandez, Vilanova, & Herrera Cuartas, 2013). A well-thought compromise between the two might therefore be the appropriate solution.

Finally, the third characteristic of a collaborative structure is a fair distribution of incurred costs and generated profits (Yang & Wee, 2006). Several studies have indicated that revenue sharing contracts can benefit collaboration between partners in a value chain, resulting in higher performance (Giannoccaro & Pontrandolfo, 2004; Govindan & Popiuc, 2014; Sijie Li, Zhu, & Huang, 2009).

2.5.6 Satisfaction of customer demands

If customer needs are not properly satisfied, a value chain is not able to survive. There has to be a continuous demand for the use of the product (Sweeney, Grant, & Mangan, 2015). According to Lacy & Rutqvist (2015) there is a misconception that customer needs are not fulfilled better in a circular economy, in comparison to a linear economy. They explain: *"The true power lies on the demand side: how a company engages with customers and their role during and after a product's use (...) the circular economy starts with a deeper understanding of demand, and ends with resource requirements and supply specifications"* (p. 24). They further explain that customers will discover that goods produced and delivered with circular business models are equivalent to, or superior to those made with linear models, in terms of their quality, performance and price. In addition, *"They will see how trading ownership of products for access translates into greater convenience, little concern over maintenance and repair, less clutter in their homes, and more money in their pockets"* (p. 25).

Apart from the demands on the performance of products and services, customers can be concerned with the environmental impacts of these offers (Belz & Peattie, 2009). Two large surveys have shown that customers naturally expect companies to design products which will minimize waste generation (Lacy & Rutqvist, 2015). Businesses can generally choose for two options in adherence to such expectations, either through certification or by being completely transparent to their customers. So not only will transparency improve the relations between partners, it can also grant companies a 'license to operate'. With respect to certification, companies are able to acquire Cradle-to-Cradle™ certification, showing their compliance to the principles of a circular economy (Braungart, 2012).

2.6 Operational resources

- Circularity enabling technologies
- Circularity measurement tools
- Dedicated staff
- Financial resources

2.6.1 Circularity enabling technologies

A value chain would not be circular if it was not equipped with the proper technologies. Generally, three types of circularity enabling technologies can be distinguished: engineering technologies, digital technologies and hybrid technologies (Lacy & Rutqvist, 2015). Engineering technologies enable better repair, sorting, remanufacturing and recycling and enable the provision of substitutes for non-renewable resources. There is still much to be gained as far as the innovation of these technologies is concerned. For instance, many of the recycling methods in the textile- and plastics industry typically involve 'downcycling', in which recycled materials are of a lower quality in comparison to virgin materials. Advanced recycling technology aims at closing this quality gap and makes use of sensors which identify and sort the various components and materials of products.

Besides engineering technologies, digital technologies (i.e. information technology) hold a great promise for transforming value chains into 'virtual value chains', which can be managed with ease (Manthou et al., 2004). Information technologies can also strengthen the relationships between partners. The digital transformation in manufacturing is usually referred to as the fourth industrial revolution (McKinsey Global Institute, 2015). Lacy & Rutqvist (2015) identified five technologies driving this transformation: mobile technology, machine-to-machine communication, cloud computing, social technology and big data analytics. Mobile technology enables customers and businesses to access goods and services at any location and at any moment of time. Machine-to-machine communication allows physical objects, such as machinery and equipment to automatically exchange information without any human intervention. Cloud computing hosts information and applications at a central location on the internet, making these accessible for many people. Social technology includes all communication- and interaction technology which can establish and maintain a relationship among companies and users. Finally, big data analytics are technologies capable of analysing and managing large and complex collections of data.

The use of digital technologies to exchange information between buyers and suppliers is not new (Agarwal, Shankar, & Tiwari, 2007). For instance, one of the most widely communication systems used in traditional supply chain management is Collaborative Planning, Forecasting and Replenishment (CPFR) (Kwon & Suh, 2005). These are a web-based supply chain applications. They collect and store data about all supply chain participants and their activities in a centralized database and make it accessible to the participants using a web-browser. It improves mutual knowledge sharing, including instant sharing of demand-, inventory- and shipping information (Chengalur-Smith, Duchessi, & Gil-Garcia, 2012). The novelty of upcoming digital technologies is that they can collect, analyse and communicate even more information, than they were able to process before. However, highly sophisticated communication technologies between people are not an absolute requirement for collaboration. In some cases, they were even identified as an obstacle in collaboration processes, because participants were becoming obsessed by it (Barratt, 2004). Consensus on what value chain partners are collaborating about is vital, as well as clearly defined processes, and a good understanding of what information is required.

Hybrid technologies include both engineering and digital technologies. The two hybrid technologies relevant for a circular value chain are track and trace- and additive manufacturing technology (i.e. 3D-printing). Track and trace technology comprises an engineering component, making use of tracking technology such as radio frequency identification (RFID), global positioning system (GPS), electromagnetic sensor systems and wireless communication, as well as a digital component related

to the software used for tracing back the assets. With track and trace technology partners have a better control over their products, components and materials and can check their status at any position in the value chain (Ellen MacArthur Foundation, 2013a). To highlight one of the technologies, RFID has great potential for improving the recovery of products, especially in the case of complex and durable goods (RAND Europe, 2005). The second hybrid technology, additive manufacturing or 3D-printing, makes self-repair easier and more accessible, improves remanufacturing. It is also capable of producing more durable goods and it can reduce the material intensity of each product. It requires an engineering component (i.e. machinery or 'printers') and a digital component (i.e. computer aided design [CAD] and 3D-images).

2.6.2 Circularity measurement system

Managers often have to justify their collaboration efforts with data that are currently not detected by their measurement systems (Barratt, 2004; Fawcett et al., 2008). Moreover, support for inter-organisational collaboration is gained by showing results. This calls for the creation of a circularity measurement system. Of course, a prerequisite for good measurement is a well-functioning information system (Gunasekaran & Ngai, 2004). The system must be developed in an integrated way. This means avoiding a situation in which parties develop their own indicators, resulting in conflicting behaviour, and pulling the objectives of the value chain in different directions (Barratt, 2004). It must also comprehend the performance of the entire value chain, and must not be assigned to functions or individuals who are responsible for reaching their own targets, because this will lead to individualistic behaviour. In this situation, managers will become obsessed with their own functions (i.e. their own activities and what they can do to reach their goals), and would, by nature, barely reflect upon the knowledge and skills of other people (Fawcett et al., 2008). This will impede collaboration capability.

A circularity measurement system consists of the tools and indicators which help managers make well-informed decisions on what they have to improve (Parmenter, 2015). It seems that there are two tools that fulfil this function best. They should be able to cover the complete lifecycles of products, for which managers ultimately bear the responsibility. These are life cycle assessment (LCA) and life cycle costing (LCC). With LCA companies are able to calculate the environmental impacts of a product's lifecycle (Guinee et al., 2010). However, the conventional methodology of an LCA is not entirely suited for assessing the impact of product-services (Peruzzini et al., 2013), despite these becoming more dominant in a circular economy. Therefore, LCA needs to be adapted in that it can calculate the impact of any extended services, such as the repair or maintenance of a product. In an LCA of a product-service combination the functional unit will be replaced by, or supplemented with the extended service. With LCC companies are able to calculate and optimize total value chain costs (Rebitzer & Hunkeler, 2003; Schmidt, 2003). This will be necessary to effectively compete with other value chains. Both LCA and LCC work in harmony (Peruzzini et al., 2013), because environmental impacts often imply extra costs (Lozano & Huisingh, 2011). For instance, with an improvement of material utilization savings on material consumption or waste collection levies can be gained. Both tools require the delineation of the value chain, i.e. setting the boundaries of the system (Guinee, et al., 2010). A tool which supports this process is value stream mapping (VSM). It maps the present state of an entire value chain in great detail, from the flow of the products and materials, to the activities and processes behind it (i.e. the material and information flow). VSM also asks managers to envision a future state, which is a critical step in realizing what can be improved. They will discover that their current value chain lacks the resources to effectively manage a complete value cycle of a product. VSM is an essential component of lean management, which stands for maximizing customer value with the least possible amount of 'waste' in terms of money, time and material. Value Chain Analysis (VCA) is a similar tool, but contrary to its contemporary use, it needs to transcend the boundaries of a single company.

With respect to the performance indicators, which is the second component of a circularity measurement system, three reports have appeared about the indicators applicable to circularity (Circle Economy, 2014; Ellen MacArthur Foundation, n.d.b; Schoolderman et al., 2014). In Table 2, a small selection of those indicators is provided to give an idea about them.

Table 2: A selection of performance indicators measuring circularity

Indicator	Description
Input in production process	Amount of input from virgin/recycled materials, or from reused components (Ellen MacArthur Foundation, n.d.b).
Utility during use-phase	Lifetime and intensity of product used compared to an industry average product or similar type (Ellen MacArthur Foundation, n.d.b).
Destination after use	Amount of material that goes to landfill/energy recovery/recycling, or amount of components collected for reuse (Ellen MacArthur Foundation, n.d.b).
Efficiency of recycling	The efficiency of recycling processes used to produce recycled input, and after material use (Ellen MacArthur Foundation, n.d.b).
Direct Material Input	The total mass of all materials of economic value that are used in production and consumption activities within the boundaries of a company's continuing operations (Circle Economy, 2014).
Direct Energetic Input	Total energetic input required for a company's full year of operations (Circle Economy, 2014).
Repair	Total revenue from repaired products compared to total revenue of all products sold (Schoolderman et al., 2014).
Re-use	Total amount of refurbished products compared to total amount of products sold (Schoolderman et al., 2014).
Technical lifetime	Estimated technological lifetime of a product (Schoolderman et al., 2014).
Leased assets	Total amount of leased assets compared to total amount of products exchanged in the market (Schoolderman et al., 2014).

Despite the urgency of collaborating in value chains, most of the displayed indicators hardly cover the circularity performance of the entire value chain. Only the indicators presented by the Ellen MacArthur Foundation can be considered suitable for use in a value chain. Still, words like 'input' and 'output' have to be replaced by 'influx' and 'outflux', because the first set of words refer to a linear process of material handling, whereas the second set refers to a material flow. A visual representation of these indicators is shown in Figure 12. They are used to estimate a total circularity score of either a product or a company, indicated as the aggregated 'Material Circularity Indicator'. The final score will also produce information about the circularity of the entire value chain, since the methodology uses very broad system boundaries. The indicators listed by the other reports are too much focused on the territory of single companies (i.e. parts of the value chain). Only if they were aggregated they could tell us something about the performance of the whole value chain.

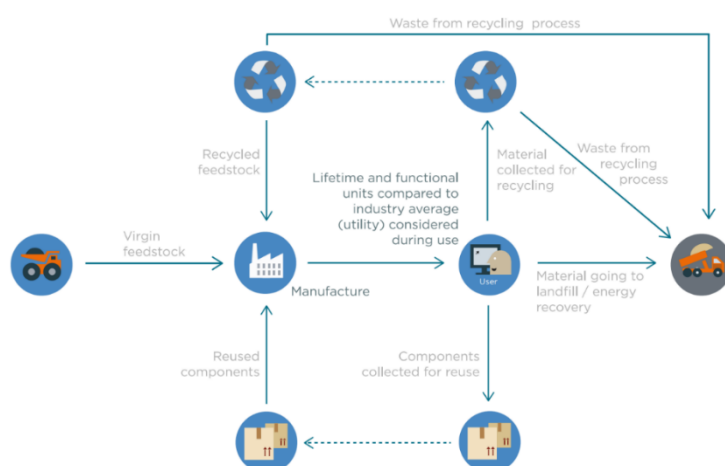


Figure 12: The material flows and indicators required to calculate the Material Circularity Indicator of either a product or a company (Ellen MacArthur Foundation, n.d.b)

The discussed tools and indicators require data from all value chain partners. Building integration and collaboration capability is therefore vital to obtain this data. Benefiting the described tools, the administration of a 'product passport' or 'bill of materials' is required, which lists all data about the components and materials of a product (Ellen MacArthur Foundation, 2013b).

2.6.3 Appropriate staff

The importance of having appropriate staff has been addressed in many studies (Gunasekaran & Ngai, 2004; Gold et al., 2010; Ying & Li-jun, 2012; Tukker, 2013). The staff of a company need to be equipped with the proper skills and knowledge to make good progress. Regarding the specific roles of top managers, Sandberg & Abrahamsson (2010) identified four roles in supply chain practices. These may also be applied to the management of a value chain. The first role is the 'value chain thinker'. Instead of taking the own organisation as the starting point for making strategy, the value chain thinker has a wider scope looking beyond the company's boundaries. Besides working actively with the company's own opportunities and resources, he is involved in the operations of other parts within the value chain. The second role is the 'relationship manager'. It is his task to judge the amount of interaction with other value chain partners on a range from intense collaboration to purely transaction-based relationships. They decide which relationship is best suitable for the situation and time given. The third role is the one of 'the controller', whose main task it is to measure, follow-up and control measurements in the value chain. The fourth and last role is the 'organiser for the future'. He is not necessarily involved in all change projects, but is more responsible for developing the required dynamic capabilities.

The above calls for an active involvement of managers. However, in the context of a circular economy their way of exercising leadership needs to be revised (Jonker, 2013). Six interchangeable competences are identified for this new type of leadership:

- raising awareness
- developing a vision
- self-confidence
- building relationships
- taking responsibility
- the ability to put it into practice

Finally, it is important to mention that the staff is equipped with sufficient knowledge about the circular economy principles. Without a clear understanding on what they behold, managers will not find a clue when their endeavours are making progress or when they are impeding it. It requires sufficient reading, and Joustra et al. (2013) have indicated this as the first step for making the right choices.

2.6.4 Financial resources

Innovation in new technologies requires investments in research and development. There must be a base of financial resources in order to pay for these. In comparison to a product-oriented business model, in which profit results from a single transaction, in service-oriented business models the generated profit is 'released' over a longer period of time. This means that businesses have to be creative in order to finance upfront costs. They can purchase assets in a similar service-based model, to reduce the upfront costs. The financial services offered by banks are currently being revised to deal with these complex issues. In addition, partners are investigating whether they can administer their finance by themselves, without intervention or help from banks. In Keiretsu, a central bank of their own is established, supporting the companies financially. Similarly, partners can administer an innovation fund together.

2.7 Managerial capabilities

- Collaboration
- Coordination
- Integration
- Stabilization

2.7.1 Collaboration

Collaboration is a first important managerial capability in a circular value chain. In general, collaboration is classified into ‘vertical collaboration’ (i.e. with suppliers and customers) and ‘horizontal collaboration’ (i.e. with competitors or other organisations), as illustrated in Figure 13. Within the value chain, collaboration expands to inter- and intra-organisational collaboration activities, as seen in Figure 14. It can be seen as a dynamic capability, which enables faster product development, enhanced quality, lower product and value chain costs, shorter fulfilment times, improved customer service, and last but not least it enables material loops to be closed (Ellen MacArthur Foundation, 2013a; Fawcett et al., 2008). Companies will improve their performance as they tap into the resources residing in the value chain. Building a collaborative relationship between buyers and sellers requires time and resources, and therefore prescribes a reduction in the number of suppliers (Kogg & Mont, 2012). It is important to communicate and make agreements on what organisations are collaborating about, before it actually takes place (Barratt, 2004).

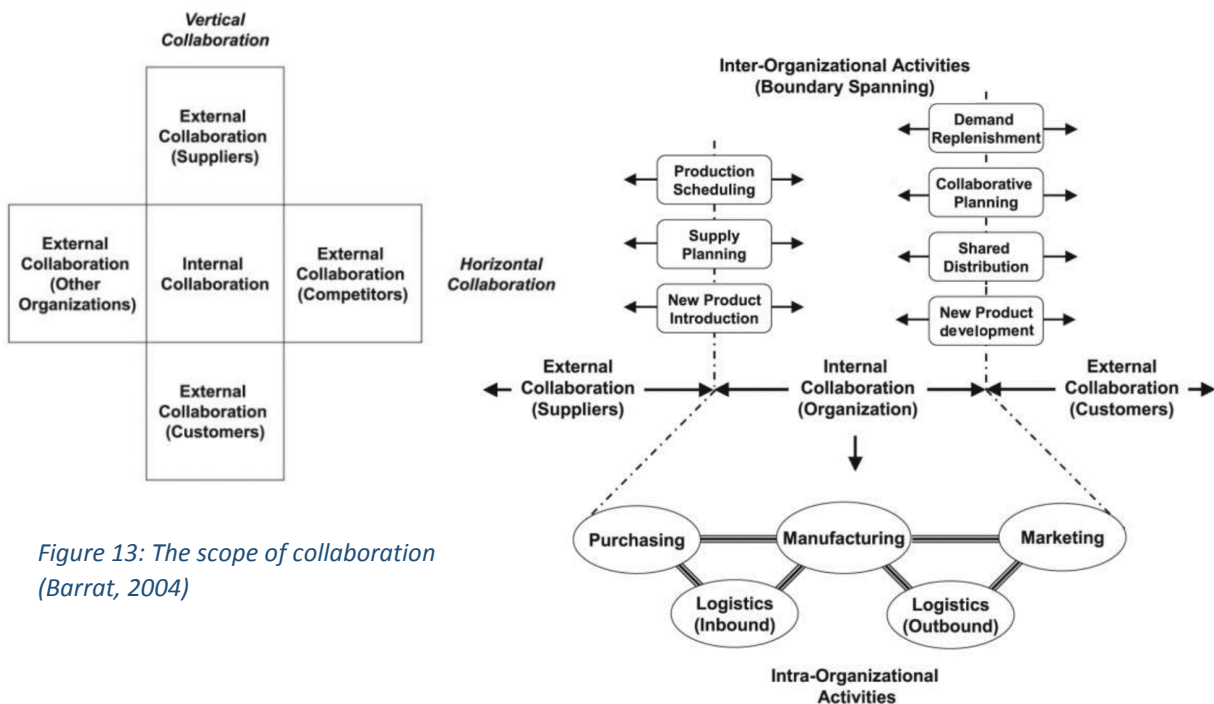


Figure 13: The scope of collaboration (Barrat, 2004)

Figure 14: The scope of vertical value chain collaboration (adapted from Barrat, 2004)

Relatively few organisations have achieved collaboration which is high enough to acquire breakthrough performance (Fawcett et al., 2008). There can be many possible reasons: the complexity of a value chain, misalignment in goals, lack of trust, inability or unwillingness to share information, inter-functional and organisational conflicts, misaligned metrics, lack of leadership, lack of appropriate staff, an inability to embrace change, misused power or poorly defined roles and responsibilities. This shows that collaboration is not an easy task. The majority of these deficiencies can be solved by goal alignment, frequent and open communication, high levels of managerial interaction, the exchange of

resources, and a willingness to share risks and rewards. Finally, a collaborative culture is based on transparency, reciprocity and trust.

2.7.2 Coordination

Coordination is the act of properly combining a number of elements, such as actions, objectives, decisions, information, knowledge, and funds for the fulfilment of the objectives of the value chain (Ghosh & Fedorowicz, 2008). The need for coordination evolves parallel to the number of chain members, who can often have conflicting goals (Ghosh & Fedorowicz, 2008). It keeps the risks at a safe level, achieves optimal performance and maximizes the profitability throughout the value chain. The absence of coordination results in higher inventory costs, longer delivery times, higher transportation costs, process inefficiencies and less customer satisfaction. Coordination is therefore a second vital managerial capability of a circular value chain. Typically, it involves the coordination of three types of flows: a material flow (e.g. products, materials and resources), a financial flow (e.g. money, cash flows, transactions) and an information flow (i.e. data, e-mails, staff meetings) (Sweeney, et al., 2015). The information flow contributes to effective coordination of the other two. Managing the three flows should be done in an integrated and holistic way. Effective coordination of the material flow is arguably one of the prime goals of a circular economy. There is still much to be gained, because not only a lot of waste is created at the end of the use phase, but also during the production process (Ellen MacArthur Foundation, 2013a). For instance, it has been estimated that in Western countries each year manufacturing consumes over 21 billion tonnes of material that is not incorporated in the products. The systems diagram of the Ellen MacArthur Foundation (2012), as was shown in Figure 1, pictures well how material flows are supposed to run in a circular economy. Many variants of this figure have been made, but all with significant similarities, implying that resource extraction from nature, and leakages to landfills and energy recovery must be avoided. It seems that consensus has been reached on how products and materials have to be handled. However, the way in which the information- and financial flow are to be coordinated remains unexplored. For many people it is unknown what information needs to be shared, whereas the act of exchanging information is deemed vital for the performance of the value chain (Ghosh & Fedorowicz, 2008). For instance, information sharing mitigates the bullwhip effect, which is one of the most researched phenomena in traditional supply chain management, and stands for the demand amplification throughout the supply chain that leads to poor customer service, excessive inventories, and lost sales (Ouyang & Li, 2010). Information sharing should be done in a pro-active manner (Akkermans et al., 2004; Sahay, 2003) and partners need to have a consultative attitude towards each other (Kwon & Suh, 2005). Regarding the financial flow, it must also be coordinated properly to reduce the chance of conflicts. Partners may need to think of other approaches for handling money than the contemporary method of each partner having their own margin in the value chain. Revenue sharing can for instance improve the performance of the value chain (Giannoccaro & Pontrandolfo, 2004; Govindan & Popiuc, 2014; Li et al., 2009).

2.7.3 Integration

Integration means the unified control, or ownership, of successive or similar processes formerly carried out independently (Cao & Zhang, 2011) and can take place at different levels of the value chain (e.g. technologies, activities, ownership structure) (Harland, Caldwell, Powell, & Zheng, 2007; Wu et al., 2006). In an integrated value chain, the overall gain of all value chain members matters, not the gain of one party at the expense of another (Boyd et al., 2007). Historically, the various activities within supply chains were managed in isolation (Sweeney et al., 2015). This fragmentation resulted in non-value adding activities that added cost and time without creating customer value. The belief that these fragmented configurations had to be replaced by more integrated architectures, is in essence what supply chain management is about. Until now, companies in the supply chain are still operating in isolation from companies that take part in the take-back chain. This also leads to non-optimized value decisions, such as the incineration of waste which could have been recycled. Many of the current activities in the areas of repair, refurbishment, remanufacturing and recycling are still carried out by different businesses. This can violate the inertia principle (Figure 2), one of the major principles of a

circular economy, because they are inclined to compete for material to make a profit. That is why especially in these 'take-back' areas integration must take place. In a circular economy, they will have to unite as 'restorers', because in one way or another they are all involved in the restoration of product-embodied values. Their prime aim will be restoring the product-embodied value with the least possible amount of value destruction.

Looking at integration from an ownership point of view, there is a spectrum which extends from a situation of multiple connected parties and their activities (Figure 15), to a situation of interchangeable activities carried out by a single party (Figure 16).

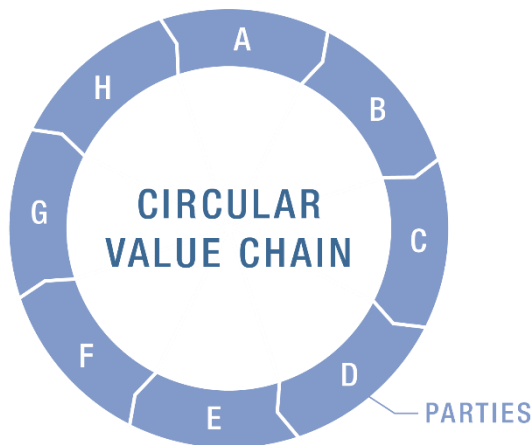


Figure 15: Joint perspective (i.e. value chain)

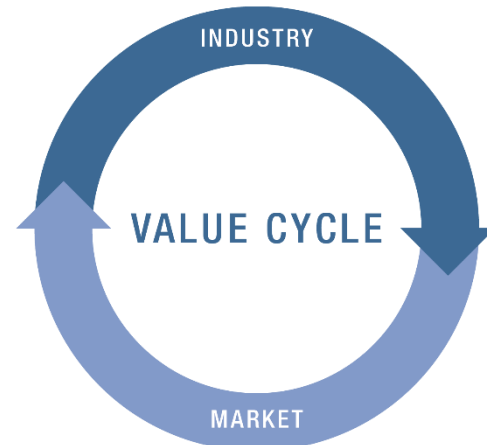


Figure 16: Single entity perspective (i.e. value cycle)

A value chain partnership can be considered as a first step in integration, when parties begin to think and act as one (Barratt, 2004). However, they continue to operate in separate companies. Eventually, the value chain could be transformed into 'a value cycle', when mergers take place or when parties create a joint venture. This single organisation will be responsible for the continuous circulation of material in the economy, comprising the industry and the market. In order to make that manageable it is advised to focus on one or a limited amount of products. In the value cycle, it is of lesser importance of what activity comes first and what activity comes second. The activities are interchangeable so that the material flow is optimized and the resource utilization rate is improved. It also means that a distinction between (re-)manufacturers, logistics providers, repair centres, recyclers, and so on is no longer made. Instead, the value cycle calls for an 'extended enterprise' (Peruzzini et al., 2013). Only the users still have a unique role to play. In a circular economy, it is imaginable that businesses will increasingly work according to this template to exert more control on the product value cycle (see Figure 5). For instance, the organisation Waternet in the Netherlands is the result of a merger of a drinking water company, the municipal water and sewage treatment organisation, and the executive department from a Dutch water board. It is the only organisation in the Netherlands that focusses on the complete water cycle, allowing them to find integrated solutions to persistent problems (Schoolderman et al., 2014). Despite such advantages, this single-entity structure does not have to be optimal for the value chain performance. In the joint structure, each party is responsible for a limited amount of activities, designed around a set of functions to obtain deep skills (Fawcett et al., 2008). This allows them to build 'core competences' (Prahalad et al., 1990). On the one hand, developing deep functional skills is likely to create conflict and impedes collaboration, but on the other hand, it enables companies to focus on the latest state of the art technologies. It can also improve communication between partners, because each party will be able to convey its expertise. Moreover, the whole structure is more heterogeneous, since employees work from separate offices and factories, allowing them to build their own routines. According to evolutionary economists, systems with a high

diversity of routines are more resilient to disruptions and have more power to innovate (Nelson & Winter, 2009). At the same time, the joint structure can imply higher transaction costs, because the system is split in businesses that make mutual transactions. Transaction costs increase when companies become more specialized, due to fear of opportunism. However, this does not always have to be the case. When transactions take place repeatedly, with a small set of suppliers, a high volume of exchange, sufficient information sharing, the use of informal agreements based on trust, and with investments in 'co-specialized assets', partnerships will have little transaction costs (Dyer, 2002). In short, this calls for a long-term collaborative partnership, primarily built upon trust. In the process of integration, the only transactions that subsist are those between the company and the users, but even here exceptions can be made. When consumers or users take part in the company themselves, the organisation becomes a blend referred to as 'prosumers'. These prosumers take care of production and delivery, but also benefit from the products that are made. Generally, these organisations are 'consumer cooperatives'. It is not likely this will ever happen with companies involved in industrial processes, but it may be expected from organisations responsible for relatively small-scale, local and simple processes, such as urban farming. However, with the rise of 3D-printing technology this assumption is not completely ruled out.

2.7.4 Stabilization

The value chain needs to function in a stable way when it aims for long-term progress towards circularity. A value chain can be considered stable if there are no parties that are better off forming new relationships or contracts among themselves or with others, and thus dropping some of their current relations (Ostrovsky, 2008). By chain stability is understood the situation when parties perceive the surrounding conditions as a given fact or something that does not change. Prior to this situation, the value chain needs a certain amount of 'absorptive- and adaptive capacity' (Choi, Dooley, & Rungtusanatham, 2001; Boyd et al., 2007). Absorptive capacity is described as a function of how open management is to new ideas and approaches, and to what extent information is shared easily along the value chain (Boyd et al., 2007). In turn, adaptive capacity can be described as a function on how this affects the value chain's composition and structure (Choi et al., 2001). Stability, subsequently, depends on the resilience and robustness of the value chain. When unexpected disruptions take place, the resilience determines whether it can return to normal operating performance, within an acceptable period of time, whereas the robustness refers to the ability of maintaining its function despite disruptions taking place (Brandon-Jones, Squire, Autry, & Petersen, 2014). A measure that could improve the robustness of the value chain is for instance qualifying a secondary supplier and assigning a small percentage of supplies to him. In case of temporary disruption of primary suppliers, the smaller supplier can take over the activities of the primary suppliers. However, working with many suppliers can also be counterproductive to the stability of the value chain, because as the number of parties increases, there are additional relationships to manage, together with additional information- and product flows to oversee. Small, localized and undifferentiated networks are therefore more robust and resilient to failure.

3. Methods




3.1 General approach

The inter-organisational resources and capabilities for organising, operating and managing a circular value chain have been described in the theory chapter. Testing their practical relevance is the next step to improve the validity of the overall framework, and will therefore contribute to answering the main research question. A qualitative methodology based on semi-structured interviews has been chosen to be most appropriate for this testing procedure, because of its explorative character and its applicability in identifying the meaning of particular phenomena to the participants (King, Cassell & Symon, 1994). Interviews can also provide a more in-depth analysis of the theory, and give the researcher the opportunity to identify new phenomena (Bernard, 1988). However, a limitation to using interviews as a primary source of data is its weakness of reliability, due to subject or participant error and bias. In preparation for the interviews and to avoid misinterpretation of the interview data, the relevant literature on the circular economy concept has been read, as well as some conferences about the topic were attended. Another limitation particularly relevant for the phenomenon of a circular economy is that empirical data is lagging behind in comparison with the theory. For instance, cases in which organisations control entire product value cycles are still rare. This problem could only partially be overcome by making a selection of the most pioneering companies and experts on a circular economy. In the rest of this chapter about the methods these organisations and people are described, as well as the procedures of data collection and analysis.

3.2 Selection of data sources

Empirical data has been collected by means of semi-structured interviews with experts on the circular economy concept and representatives of companies applying circular business models. They have been selected based on their involvement in the circular economy debate at conferences and news media, or they were suggested by peers. All of these companies are headquartered in the Netherlands, a country where as much as half of the companies are familiar with the circular economy concept (NVL & GfK, 2015). In Table 3 an overview of all the interviewed organisations, their sectors, and their relevance to this research is provided.

Table 3: Overview of interviewed organisations

Organisation	Sector and relevance
 Sustainable Value Cycle Solutions	<i>[Consultancy]</i> Sustainable Value Cycle Solutions (SVCS) provides guidance to companies on how to combine best practices and product development with an eco-effective sustainability approach. Andy Hall, director of this company, has been consulted by a variety of businesses (e.g. Philips, Toyota, Heineken) and has also been working with Michael Braungart, writer of 'Cradle to Cradle: Remaking the way we make things', to develop the Cradle to Cradle certification standard for complex products (A. Hall, personal communication, September 19, 2015 & www.andyhall-svcs.com).
 Radboud University	<i>[Research]</i> From the School of Management of Radboud University, Jan Jonker is a professor in sustainable entrepreneurship. His research focusses on the transformation of contemporary unsustainable business practices to sustainable ones. Together with more than thirty co-authors, he reveals some of his latest findings in the book 'New Business Models'. (J. Jonker, personal communication, November 5, 2014 & nieuwbusinessmodellen.nl)
 BLUECITY010	<i>[Food, textile, interior, white goods]</i> BlueCity010 is a group of companies from different industries, stationed in a renovated office which used to be an abandoned swimming pool in the city of Rotterdam. Besides the fact that they have given an abandoned building a new purpose, which can be considered circular, the companies have aligned their business models and

	matched their material flows (A. Piscaer, personal communication, October 10, 2015 & bluecity010.nl)
	<i>[Electronics]</i> The start-up Pelican House applies a product-service model to electronic devices and advocates the embracement of a circular economy by the electronics industry. They made it possible to lease modular headphones. In the not so distant future, they will close their material loop in cooperation with recyclers and their suppliers (T. Leenders & D. Galama, personal communication, September 30, 2015 & pelicanhouse.nl).
	<i>[Engineering and consultancy]</i> Royal HaskoningDHV is an engineering and consultancy company active in various parts of the world. It has expanded its consultancy services with the circular economy concept and became involved in three related projects, called 'EcoProFabrics', 'Recover-E' and 'Take Back Chemicals'. All projects required the partnering of different companies in the value chain (E. Pfeiffer, & V. Paginu, personal communication, September 15 and October 10, 2015 & royalhaskoningdhv.com)
	<i>[Waste management]</i> Attero is a waste management company, which develops new business cases in collaboration with other companies with the aim to close material loops. In one of their latest projects, called 'Waste2Aromatics', they have shown a viable business case for retrieving carbohydrates from organic household waste for the production of bio-aromatics (F. Goosens, personal communication, September 22, 2015 & attero.nl).
	<i>[E.g. waste management, finance, logistics, research]</i> Circularity Center is a network of organisations, including, amongst others, a waste management company (Van Gansewinkel), the Port of Rotterdam Authority, a financial service provider (Rabobank) and a research institute (TNO). The group tests circular business cases and scales them when they are deemed viable (F. Slob, personal communication, October 19, 2015 & circularitycenter.nl).
	<i>[Waste management]</i> Van Gerrevink is a company involved in the recycling of many types of household and industry waste. They enter various collaboration projects aimed to close material loops. Currently they are collaborating with a manufacturer to make their products recyclable, and introduce a product-service system (M. van Gerrevink, personal communication, November 11, 2015 & vangerrevink.nl).
	<i>[Interior]</i> Interface, one of the world's largest carpet manufacturers, is a pioneer in integrating circular practices in its business model and is known for its mission to reduce their environmental impact to zero by 2020. One of their partnerships is called Networks, which collects discarded fishing nets from the sea and converts them into new carpet yarn (G. van Arkel, personal communication, September 23, 2015 & interfaceflor.nl).
	<i>[Finance]</i> ING, one of the largest banks in the Netherlands, is currently active in identifying financial services for circular business models. The bank recently published a report, called 'Rethinking Finance in a circular economy', highlighting their first results (G. Naber, personal communication, October 12, 2015 & ing.nl).

	<p><i>[Construction]</i> Cablean applies a product-service model to a multifunctional device to be installed on outdoor construction surfaces. They collaborated with Tata Steel, the sixth largest steel manufacturer in the world, to design this product in a way so that it can be easily disassembled and recycled (R. van Bommel, personal communication, September 28, 2015 & cablean-group.com).</p>
	<p><i>[Textile]</i> ReBlend is a partnership of a post-consumer textile collector (Sympany), a textile innovation centre (Texperium), a fashion designer (Bybrow) and an interior company (Ahrend) with a mission to recycle existing textile waste into new products (A. de Wit, personal communication, September 28, 2015 & reblend.nl).</p>
	<p><i>[Textile]</i> Texperium is an innovation centre with an expertise on textile recycling. They initiate and participate in various kinds of partnerships geared to close textile material loops (P. Bos, personal communication, October 15, 2015 & texperium.eu).</p>
	<p><i>[Textile]</i> Groenendijk is a retailer of workwear and is currently collaborating with recyclers to investigate how they can make their clothing line circular (personal communication, September 25, 2015 & groenendijkbedrijfskleding.nl).</p>
	<p><i>[Textile]</i> Dutch aWEARness is a retailer of circular work wear. Some years ago they launched a project called EcoProFabrics, a partnership agreement of companies whose mission it is to close their material loop in which they have succeeded. Dutch aWEARness also consider themselves as a pioneer in circular value chain management for the textile industry (I. van Wanrooij, personal communication, December 3, 2015 & dutchawearness.com).</p>

3.3 Data collection and analysis procedure

All the interviews took place face-to-face, and lasted for approximately one to two hours. Halfway the interviews, saturation of data began to take place, indicating that the collected data is complete. The interviews consisted of questions related to the theoretical framework, covering the inter-organisational resources and capabilities. See Appendix E for the list of standard questions. Questions that were asked first were as open as possible, to prevent a bias towards the existence of particular resources and capabilities, and to create the possibility of capturing new phenomena. In many instances, subsequent questions were asked to receive further clarification. At the end of each interview, the framework was shown so interviewees could provide commentary on its containing elements. This contributed to further improvement and validation of the framework. The interviews were recorded, so that they could be transcribed in a later phase. After the transcriptions were complete, they were uploaded in a qualitative data analysis tool, called NVivo. Then, many of the transcript clauses were labelled according to the elements of the framework. This is a method called 'thematic content analysis' (Burnard, 1991). New findings were labelled separately and when similarities began to appear they were aggregated into a new label. After the data had been sufficiently structured, a more careful study on the labels and corresponding elements of the framework took place. The transcripts and the coding tree from NVivo are available on request after approval of the interviewee, to provide transparency in the data collection and analysis procedure, and to improve data reliability.

4. Findings

In this chapter the findings of the data analysis of the interviews will be presented, beginning with the organisational boundary conditions. After that, the findings on the operational resources will be explained and finally, the managerial capabilities will be addressed.

4.1 Organisational boundary conditions

<ul style="list-style-type: none">• Joint identity• Parties' self-interest, support and commitment	<ul style="list-style-type: none">• Safeguards against failure and opportunism• Transparency	<ul style="list-style-type: none">• Collaborative structure• Satisfaction of customer demands
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4.1.1 Joint identity

A joint identity was seen as an important boundary condition for successful collaboration. All of the factors identified in the theory for having a joint identity were found relevant in one way or another. These include a brand, core competences or core product portfolio, a shared vision, shared objectives, shared interests, shared codes of conduct, shared norms and values. Some of these were being perceived as more important than others. In addition to the previously identified factors in the theory, it was found that when companies compete against the same parties, this can also improve the mutual relationship between partners. This confirms the idea that nowadays partnerships are competing amongst each other, apart from the competition that already takes place between companies individually.

Having a shared vision was felt to be the most important determinant for a joint identity. Without a shared vision, collaboration will be a big chaos, one interviewee noticed, and it would not be possible to work together, some others explained. However, some other interviewees noticed that partners need to have the same norms and values in the first place, otherwise it would not be possible to create a shared vision together. Someone explained: *"Of course you may have the same product portfolio, shared objectives and a brand name, but what really makes a joint identity is a shared sense of norms and values of the individuals working in the alliance"*. Shared norms and values are therefore the major foundation for the creation of a joint identity, resulting in a shared vision. A shared vision can subsequently be moulded into shared objectives, which are more concrete and can even be as tangible as contracts. Of these three elements, the objectives are clearest. This sequence is pictured in the pyramid of Figure 17.

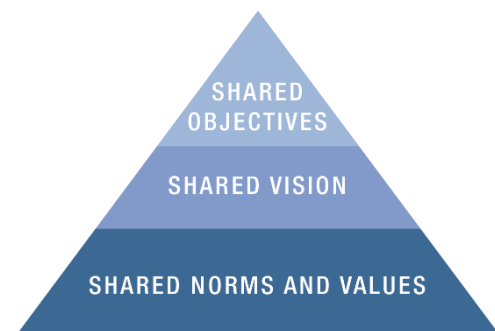


Figure 17: The establishment of a joint identity

Interviewees regarded brands as the headings of partnerships. It is about recognisability and communication to external parties, as part of a marketing strategy targeted at customers. That is why brand names of retailers were thought to be more attractive than those of other parties within the alliance. One interviewee noticed that having a single brand can also boost collaboration. Similarly to starting a joint venture, it unites all parties as if they were one.

The core competences of the partnership define what the partnership sets apart from working separately or other collaboration initiatives. One interviewee stressed the importance of being distinctive. If the partnership is not, one can wonder why everybody would not continue to work

separately, she said. The interviewees felt that within a partnership they were able to provide their customers a much broader value proposition. This may be the distinctive feature of a partnership.

The joint identity can also be the result of a particular product portfolio. One interviewee expressed that their partnership is built around a set of core products. If members wanted to introduce other products they were free to do so, but in a different context than their partnership. This way of looking towards a circular economy is very relevant for the concept of a value cycle, because of its focus on a single or a few products. Some parties in the value chain, such as waste management companies or suppliers of material and subassemblies, may find it hard to think in terms of complete products, but a representative from a waste management company thought that this was required.

As was explained in the theory chapter, the joint identity can be formalized. In some cases, a joint identity existed in the form of a declaration. One interviewee explained that when they had signed a declaration, everybody was assured that they were heading for the same direction. In a later phase, such a declaration may act as a reminder for the reason of working together. Another interviewee said that when all parties were being asked to phrase what the partnership was about, it helped them to distinguish themselves from other partnerships. Formalizing a joint identity for external parties may also help to gain required publicity, and to receive support from governmental agencies in terms of legislation. In general, governments are more responsive to lobbies of groups than to those of individual companies.

Particular codes of conduct were also found relevant for having a joint identity. In most of the interviews these codes were expressed as unwritten rules, ingrained into cultural habits. They thus resemble the earlier identified shared norms and values. One interviewee stressed the fact that the rules are part of a culture, and simply putting them on paper can be helpful, but will say little. The behaviour incited by these unwritten rules are focused on transparency, altruism or reciprocity.

Having a strong joint identity is important, but it needs to be sufficiently open, so parties feel comfortable and the identity can change naturally. Some of the aspects, such as the objectives, should be open to be revised every year, because best practices of circular systems are still evolving and the implementation of circularity is seen as a dynamic process.

4.1.2 Parties' interest, support and commitment

All of the interviewees confirmed that the interest, support and commitment of parties is a vital boundary condition for successful collaboration. For instance, one of the interviewees said he was not going to 'flog a dead horse', when he experienced too much resistance. Another interviewee said he does not try to persuade people, but instead searches for people who are like-minded and want to bring circular economy into reality.

Several interviewees confirmed that parties have a tendency to remain silent about their self-interest in collaboration initiatives. Sensitive questions that can remain unanswered are whether the collaboration fulfils a short-term affair or a long-term relationship, if it is aimed for a merger or a take-over of one of the parties, or if certain parties are participating for a specific reason aside from the overall goal. The pretence of non-existent self-interest is breached by communicating openly. Therefore, at the beginning of a collaboration initiative it has to be clear what everybody wants to gain by it. In fact, collaboration will only succeed when each party receives some type of payment for the work they put in. This will be further elaborated in the section about collaboration capability. Even though some interests of partners may seem obvious, paraphrasing them was found to be helpful for the collaboration process. Openness on each other's interests complements an openness on each other's roles in the value chain. In situations where roles overlap, the possibility of conflicts is deemed high, so when each other's roles are defined in a sharp and distinctive way, the collaboration will be enhanced. Parties will know what their jobs are and will not overlay their activities with those of their partners. Naturally, companies want to feel most responsible for the part of the chain with which they are already familiar to. This way the parties retain some of their desired self-identity. For instance, one representative from a retailer explained that although his business is now collaborating with recyclers, they would never want to see recycling become part of their core business. In situations where conflicting interests subsist, simply mentioning and accepting them was found to be vital for preventing future conflicts.

With respect to the general support from parties, the support from top-management is considered to have the most impact. For instance, one interviewee explained that without an executive sponsor projects are doomed to fail. Top managers need to give their employees enough freedom to experiment. They are also required to be patient, as one interviewee explained that it is nearly impossible to create a self-sustaining business within a year. It will take at least three years, he said. As was suggested in the theory, displaying the business case is the best way to build support from top-management, followed by sufficient communication about the collaboration to retain the support. The results or fulfilment of goals also have to be celebrated accordingly. One interviewee expressed that support for collaboration was most difficult to gain from shareholders. Interestingly, another interviewee explained that for her this was not a problem at all, because in her experience shareholders are not in businesses for quick cash, but instead look for a long-term steady return on their investment. Building support in the rest of the organisation is also deemed important, which is best paraphrased by the following quote: *"Perhaps you can collaborate fantastically with the six representatives of the participating companies, but if you are with six people and the other five thousand people are doing something else, you will not get the most out of the collaboration"*. The rest of the company has to become proud of the collaboration and this is achieved by organising workshops for instance, or with back and forth presentations given by the representatives of partnering companies. Naturally, smaller companies have less problems finding support in their own organisations than larger companies, because smaller companies are found to be less bureaucratic.

Finally, by commitment most of the interviewees understood putting energy, time and money into the collaboration. It could mean joining in meetings, visiting each other's factories, the willingness to invest in each other, or simply a quick reply on each other's e-mails. Showing commitment was deemed important for the stability of the alliance, as one of the interviewees said: *"If you are leaning back, problems will begin to appear"*.

4.1.3 Safeguards against failure and opportunism

As was described in the theory chapter, every partnership risks failure or opportunism. The risks of failure mentioned by the interviewees are companies going bankrupt, or companies being unable to deliver what they initially promised. The mentioned opportunistic risks are companies with a hidden agenda, or companies that reap ideas and continue to pursue them alone or with others. They are substantially lower when parties come from different sectors or when there is no direct competition. Ideally, there are no competitors within a partnership, but there are exceptions to be made. For instance, in some partnerships the parties can be involved within the same value chain activities. In these cases, they need to be clear about their roles. Sometimes the inclusion of competitors to save on costs, to scale or to reach sufficient mass is also needed. In all these cases, solid agreements between the competing parties have to be made. Retailers can for instance make an agreement on which regions they are allowed to work in, and suppliers of materials and components can make an agreement on the quantities they supply in comparison to each other. Of course, these agreements should not undermine the laws about monopoly, cartels and competition.

Continuing with the role of formal agreements to prevent failure and opportunism, all interviewees explained that they were using those in one way or another. It seems that a partnership cannot function without at least a few of those agreements. They implement some kind of safety-net. At the beginning of collaboration, general cooperation agreements are mostly dominant, whereas in later phases specific contracts are used, such as supply agreements. In most of the value chains of today, bilateral contracts are used between suppliers and customers. Regarding those contracts, one interviewee said: *"I do admit we use those, but I must say it is a bit strange. We build a circular value chain with each other and we are all operating a single virtual company, but we are still using bilateral contracts among ourselves"*. With that he indicated that bilateral contracts may not be part of a circular value chain, with the exception of the ones between the companies and the users. Furthermore, the signed non-disclosure agreements (NDAs) were either about concealing the fact that particular parties are collaborating, or about preventing that confidential information is shared with external parties. For the sake of transparency, the first secret about partnering companies becomes disclosed once the developed product is brought to market, whereas the nondisclosure of confidential information remained effective. Not making any formal agreements and completely relying upon trust was found to be naïve and stupid, as one interviewee explained metaphorically: *"Not using contracts is like going on a holiday without an insurance (...) the further the trip, the better you want to secure yourself"*. One interviewee noticed that from his experience of his work in supply chain management, contracts were used in an inappropriate way. They were not seen as an agreement, but as a means to fight each other. They were used to divert responsibilities and to blame each other, and often included high penalty clauses. He called it the traditional way of setting up contracts, instead of focusing on collaboration and helping each other. Contracts should therefore not be too strict, as another interviewee explained. He said: *"When you shake hands and you see the business case, that is the most important (...) Once the legal departments come together this can easily cost you another year"*. On the other hand, as was mentioned before, the role of contracts becomes increasingly important in situations of multiple parties. One interviewee confirmed this when she explained that contracts become broader and heavier when more partners are involved. Besides, as was also mentioned before, formal agreements were found to play a greater role in structures of asymmetric bargaining power, which refers to the situation in which parties with more resources are able to exploit parties lacking these. Two interviewees expressed this fear of abuse when they claimed to have more difficulty in trusting someone from a larger firm, than from a small-sized firm comparable to theirs. Finally, contracts were increasingly being used in service-oriented business models, because of the shift from one-time transaction contracts to long-term service-contracts. Throughout time, the role of contracts generally becomes less important, as one interviewee noticed: *"Initially we were obsessed with contracts, but now we say, it is convenient that they are there, but we hardly look at them anymore"*. The role of formal agreements is therefore being replaced by informal relationships based on trust.

In the theory chapter it was mentioned that in addition to the use of formal agreements, trust acts as an important safeguard against failure and opportunism. This was confirmed in nearly all interviews and was generally perceived to be more important than contracts, although it was not intended to be a replacement of contracts. One interviewee phrased how trust complements and solves the inadequacy of contracts: *"Making an agreement when you do not know how things will turn out is really hard, especially when each party tries to divert his risks to others (...) As a starting point for collaboration this doesn't feel right. So eventually we said, let's stop nagging and have some trust in each other"*. As explained in the theory chapter, trust is built as the result of intense communication between partners. Several of the interviewees believed that trust is best created with face-to-face interaction, although one interviewee believed that online communication is equally effective. Trust was also found to be transferable, especially when companies have built a reputation. In two interviews this linkage between reputation and trust was confirmed, when one of the interviewees said: *"You build a network of people you trust, and can consult them in a later stage"*, and the other said: *"I ask my colleagues to find out which partners are trustworthy"*. As far as the relationship between transparency and trust is concerned, one interviewee had this to say: *"The highest level of trust you can obtain is when you are allowed to take a peek into somebody's financial administration at any time"*. Of course, this depends on the willingness of this partner to disclose his financial information. The next section will further elaborate on this topic. Finally, trust emerges when partners share the same norms and values or when they share the same vision, referring to the boundary condition of a joint identity.

The relationship between trust and formal agreements is quite intriguing, as one could argue that contracts can also diminish trust levels. For instance, one interviewee noticed: *"When a NDA pops up, the parties are basically saying that they don't trust each other"*. Some have referred to the paradox between trust and contracts with comparing it to the prenuptial agreement when people marry; partners have faith in each other, but just in case something goes wrong in the future it may come in handy when things have been taken care of. That is the reason why in most interviews they were found not to be mutually exclusive, but complementary. This is also what the theory indicated. The relationship between contracts and trust may best be wrapped up with the following quote of an interviewee: *"I am not really a fan of NDAs, (...) but sometimes we cannot do without. It is also about business ethics. You can only fool each other once, and if you do that, you won't be taken seriously anymore. In the end it is about the trust you have in somebody else"*.

4.1.4 Transparency

As was described in the theory, transparency is seen as another boundary condition for effective collaboration in a circular economy. This was confirmed in many of the interviews. For instance, one interviewee said: *"You need to create openness within a team and project"*. Another one added: *"Collaboration sounds easy, but it is only easy within a culture of transparency"*. Disclosing all information is not always desired by parties working together. A reason for that might be a lack of trust. Partners are advised to consider carefully what information needs to be shared and what is not required to be shared in order to make collaboration succeed. They are more willing to share information when the act of sharing has a purpose. On the other hand, they are willing to share everything and expect their partners to do the same. One interviewee explained: *"It goes really far, all of our partners and even our customers know what we earn"*. It could also be sensitive information, as one interviewee said: *"In quite an early phase, even before a contract is signed, you have to be willing to share sensitive information, though that may sound exciting, that is needed to quickly discover if you can make progress together"*. Disclosing information about an innovative technology may also be required, because when more companies begin to use that technology, real innovation is taking place.

The data from the interviews indicate that three types of transparency exist, which are relevant to a circular economy. One of those types has already been described in the theory chapter. This was the openness on each other's self-interest and roles. The other two types of transparency to be distinguished are operational transparency and financial transparency. Operational transparency stands for the openness to share information on the operational aspects of the value chain, from the whereabouts and conditions of components and goods, to the energy consumption and sources, material in- and outputs, use of chemicals, and pollution. Operational transparency was found necessary to discover what can be improved, to monitor progress, to live up to customer expectations, and for a good coordination of all activities within the value chain. It also means that partners are allowed to check each other's processes to see whether they speak the truth. With operational transparency, customers or other stakeholders also get to know if the value chain is organised in a circular way. The second type, financial transparency, is the openness of sharing information on price- and cost structures of products, services, and the processes along the value chain. This is generally known as 'open-book accounting'. The reactions in the interviews about this topic differed substantially. It was found to be sensitive, as one interviewee pictured: *"In the field of information sharing a significant step has to be taken, but open-book accounting requires an even greater step"*. Another interviewee explained why this topic is so sensitive: *"Many companies within the current value chains aim at profit maximization in relation to each other, so they will struggle with this"*. He believed that this model of profit maximization would not last. Another interviewee even explained that profit maximization is impossible to strive for in a circular value chain. In general, it was found that parties are more willing to disclose financial information within the partnership than with the outside world. In the interviews, both arguments in favour and against the idea of increased financial transparency were heard. The arguments in favour were the understanding of how costs and profits are distributed along the value chain, to develop a new product, or to build a valid business case. It also shows that partners go really far to foster collaboration. As was noted previously, it can create the highest level of trust. At the same time, it requires pre-existing trust to disclose this information. The arguments against more financial transparency arose from the feeling that this was unnecessary. One interviewee explained that prices are usually known to the market. Another interviewee said that with simple calculations price- and cost structures can be determined by partners themselves. In other occasions, disclosing this information may become too personal, especially for one-man businesses.

4.1.5 Collaborative structure

Recalling the theory, there are three characteristics of a collaborative structure. These are collective ownership, democratic decision-making, and a fair distribution of costs and profits. Collective ownership was achieved by giving all partners access to the resources residing in the value chain partnership. In three interviews this was clearly identified. In one of them, the sharing of resources

was even remarked as the great benefit of collaborating for circularity. Another interviewee from another company referred to the 'airline alliances' for their partnerships. He explained that there are three large aviation alliances in the world, each consisting of fifteen to thirty different airlines. To offer their customers a better value proposition, they share many types of resources, such as sales offices, maintenance facilities, operational staff, and the lounges at airports. The third interviewee explained that the employees of their partners are always welcome to make use of the laboratory of the company.

With respect to giving all parties a voice in decision-making, several interviewees confirmed that this was an important boundary condition. One said: *"When you build circular economy together, you do that from the conviction that each link and thereby each party, small or big, is equally important for the overall success, and that means that each party has the same amount of influence"*. At a later moment of the interview he specified that any previous investments or capital-intensive processes do not legitimize an increase of decision power. He further explained that for his partnership each party is entitled to exercise a veto: *"When major changes are proposed, everybody has to agree unanimously"*. Although the rest of the interviewees agreed that all parties must have some control in decision-making, there was still a debate going on about what specific amount of decision power each party may have. On the one hand, businesses who invest a lot of money in the partnership naturally expect to gain more decision power, because their money is at stake. On the other hand, parties without financial resources may bring in other, more intangible resources, such as ideas that others would never think of. Valuating intangible resources in terms of money is difficult, if not impossible, but they could be worth the same or even more than the amount of money another company has brought in. This was found to be the major argument for allocating the same amount of decision power to each party. Granting the same decision power to those without the financial resources might be difficult for the richer companies, but it could benefit the collaboration. The findings on the final characteristic of a fair distribution of costs and profits will be dealt with in the section about the coordination capability of the financial flow.

The debate on hierarchic and flat organisational structures identified in theory could also be noted in the interviews, and in some way resembles the debate on the amount of decision power. The one and major argument in favour of flat structures is to promote equality, thereby reducing the risk of conflicts. The arguments against flat structures, but in favour of hierarchic ones are focused on sustaining fast economic progress. The interviewees that shared this opinion indicated that flat structures are delaying progress, because people tend to wait for each other or because the decision-making becomes too complicated. Therefore, they think that in all cases one of the partners must be in charge. Since the companies of these interviewees were in charge of their partnerships, this opinion might be biased. It could further be observed that in most partnerships the leading company is a retailer (i.e. the party that brings the product to market), presumably because they have the largest interest in selling the complete product. However, some interviewees explained that this does not always have to be the case. Finally, in an early stage of collaboration some interviewees thought that flat structures are most effective, but need to be replaced by more hierarchical structures in later stages, so it would become 'business as usual'. Others, at least for the beginning, expressed the opposite, for the same reason as was mentioned before, that one party must 'pull the wagon' to make a fast and early progression.

Not one interviewee expressed a clear preference for one of the legal ownership structures. In fact, the relationships were not always anchored in law, because they did not assume that this was necessary. They explained that the right choice for a legal ownership structure differs in many situations, so in practice it could be any one. However, a few interviewees were interested in the cooperative, which was dealt with in the theory chapter. They felt that the philosophy behind a cooperative is most aligned with their way of distributing power in partnerships, and it could also guarantee that costs and profits are distributed equally.

4.1.6 Satisfaction of customer demands

One interviewee stressed the importance of satisfying customers when introducing a circular product or service to the market: *“If there is no demand, you are out of business, there will be no launching customers and you will not receive any money from a bank”*. Another interviewee phrased their ‘access to market’ as a fortunate condition, that other companies may struggle to develop. She explained how they were in just the right position to easily sell products with recycled content. In other markets, she continued, customers may fear a loss of quality.

Not every interviewee felt that customer demands would be better satisfied in a circular value chain than in a traditional supply chain. This may be the same misconception as was identified previously in the theory. A few interviewees clearly expressed the opposite, of which one tried to explain why this misconception exists. With respect to a circular economy, he said that there is still a lot of noise, and that it would only stand for closing material loops. Indeed, the reusability or recyclability of a product does not add value from a customer point of view, but the design for modularity and upgradability certainly does. These are important design strategies required for the inner loops of a circular economy, i.e. maintain and prolong. Customers can even be empowered to repair or upgrade the products by themselves. For instance, the idea that customers do not need help from a company to replace or repair the components of their smartphone, is now portrayed as a unique selling point in one of the commercials from a manufacturer of smartphones. The interviewee continued that many customers are also irritated by the short life span of products. The fact that in a circular economy products are designed to last, will therefore also benefit the customer. Many other customer benefits are related to the product-service models, when companies have incorporated services in their offers. If for any reason the service is no longer fulfilled, the company is responsible for solving the problem, instead of the customer having to deal with it. In service-oriented models the ownership of the materials and goods also remain in hands of the provider, which is in line with a growing customer market that is not attracted by ownership. They favour experiences over ownership, and purely want to pay for access to, or use of, the products.

The interviewees perceived that in business-to-consumer markets the demand for circular products and services is less than in business-to-business markets. A reason might be that the concept of a circular economy is for the greater part only known to people from business. It will probably just be a matter of time before it becomes known to the general public, in a similar way as how sustainability has become known to many people. Given the situation that users still have little understanding of what circularity means, companies are advised to carefully reflect upon their positioning of their new ‘circular’ products or services in the market.

Regarding certification, a few interviewees felt that it is a useful technique to check whether a company’s claims are in fact true. However, for several reasons, most of the interviewees were sceptic about certification. First, they expressed that there is an abundance of sustainability certifications and labels in the market. Introducing even more for the purpose of circularity would cause even more confusion among customers. The second reason why certification is refrained from is that they had the feeling that little value is added for customers. They explained that customers purchase products for their function alone, and not because they happen to be circular. If certification was rewarded properly (e.g. a discount on VAT), companies would become more interested. The third reason for the sceptic attitude was that certification was perceived to be an industry in itself. The interviewees expressed it can be a costly expenditure. The final reason may had to do with the extra work certification brings in terms of administration, monitoring and checks.

As was explained in the theory chapter, businesses can bypass certification by being transparent. It was confirmed that operational transparency is a way to gain a license to operate. Companies can openly communicate the things they do right in a circular context, and what can be improved. The information desired by their customers can be provided on their websites, as well as in their annual reports. It was also thought that opening the doors of factories to journalists is part of this

transparency. One interviewee explained that for a circular economy journalists do not have to know the technical details of processes, as long as the inputs and outputs of machinery equipment is shown. Businesses therefore do not have to fear that sensitive information will leak to their competitors.

4.2 Operational resources

- Circularity enabling technologies
- Circularity measurement tools
- Dedicated staff
- Financial resources

4.2.1 Circularity enabling technologies

Despite the many opportunities for innovation in technologies that enable circularity, that were addressed in the theory chapter, interviewees did not lack the technology for letting circularity flourish. Two of them thought that the biggest challenge lies in persuading customers to pay for the use of products, instead of owning them. They believed that technological problems are always solvable. This might be true when looking at the diffusion of engineering and digital technologies that is taking place in industry. With regard to digital technologies, the interviewees agreed that these will greatly contribute to making a circular economy come true. One of them explained that he was not surprised when Google, one of the leading companies in information technology, decided to partner with the Ellen MacArthur Foundation, because according to him, Google knows that information technology will play an important role in a circular economy. It was also observed that digital technologies can complement the variety of tools that make the measurement of circularity possible, such as LCA and product passports. Track and trace technology is one of those, but to make 'track and trace' work, the inclusion of new technologies is not always required. The conventional use of serial numbers, production runs, or lease contracts can all be utilized to track and trace products, but when companies are using a tracking asset (e.g. RFID chips, barcodes, QR-codes) they have to be cautious, because they could pollute material streams. If the tracking assets consist of the same materials as the rest of the products, or if they can be detachable, this problem will be solved. However, in the case of the assets being detachable, companies do run the risk of the assets getting lost, and it would result in another sorting step to be created in the recycling process.

4.2.2 Circularity measurement system

The interviewees thought that the purpose of a circularity measurement system is primarily meant for self-assessment, instead of using it for external communication. However, investors could benefit from such a system to assess whether their investments are future-proof. Banks are also increasingly taking into consideration a company's supplier base to determine loan grants. The interviewees further agreed that creating a measurement system must be done in an integrated way with, taking into account the opinion of all partners. One of the interviewees thought that measuring circularity is difficult, because according to him, much of value exists in intangibles. He believed that measuring circularity can only be done by measuring the final impact (i.e. the total revenue generated by circular business models). Despite this observation, in the theory chapter, several tools and indicators were identified which contribute to measuring circularity. Based on the interviews one additional tool could be identified, called 'material flow analysis' (MFA), which quantifies the flows and stocks of materials in a well-defined system. In Table 4, an overview of all the tools is shown, after which the findings on some of those tools are discussed.

Table 4: The variety of tools contributing to circularity measurement of the value chain

Value Stream Mapping (VSM)
Value Chain Analysis (VSA)
Material Flow Analysis (MFA)
Life Cycle Assessment (LCA)
Life Cycle Costing (LCC)
Total Cost of Ownership (TCO)
Product Passport (PP) / Bill of Materials (BoM)

One interviewee explained how they had just begun implementing circularity, and how they were busy with mapping their suppliers. This confirms the idea that companies first need to understand the system they are operating in, so they can determine its performance in a later phase. The interviewees saw LCA as an important tool for a circular economy. One of them explained how LCA helped them to measure the impact of the whole value chain, and identify the processes with the largest impacts. However, it was also felt that in LCA too many assumptions were being made and they questioned whether the system boundaries were drawn properly. Drawing the right system boundaries in a circular economy is a difficult challenge, because circular systems have no starting points or ends. Therefore, being honest and clear on the assumptions made is of vital importance. In this case, an environmental product declaration (EPD) is helpful, because agreements are made on the assumptions beforehand, making the impact of products comparable for entire industries. Another interviewee noticed how LCA was sometimes used in the wrong way. He explained that when the results of an LCA indicate that when during the use-phase the largest impact is created, companies tend to ‘point fingers’ and to feel less responsible. In a circular economy, companies will also be held responsible for the environmental impacts created during the use-phase. According to Thomas Rau, founder of a company advocating service-oriented business models, they even pay for the electricity consumption during the use-phase, so they have an incentive to reduce the impacts related to that. This approach can be extended to all sorts of products that require an input, such as washing machines needing detergents, or shower systems needing water. Furthermore, when companies begin to collaborate in partnerships, the reliability of the data being used can be improved, because more unit process data (i.e. reliable data from factories and processes) can be collected. One interviewee explained how they were all obliged to provide data for the LCA. With respect to LCC and TCO, they were found to be often used, but not always consciously as a tool. For instance, in one case the costs throughout the value chain were added up, to find out whether a valid business case existed. In another case, this was done to determine how the profits could be distributed fairly, so that parties with more costly processes received a higher share of profit. Not all the tools were found to be equally applicable in all situations. For instance, LCA was found more applicable in situations with a closed material loop, because of its focus on single products, whereas MFA was found to be a better tool in systems in which the ‘waste’ from one production process is the input for other products. Finally, product passports were found to be very useful in support of other tools, especially when they are combined with track and trace technology. Product passports would then become ‘active’ information carriers, instead of being used passively for the retrieval of information.

As was described in theory chapter, performance indicators comprise another important component of a measurement system. The interviewees noticed that performance indicators for circularity would not differ that much from traditional indicators. Some of them thought it was better to design indicators focused on measuring the transformation itself, instead of keeping track of the final performance. Counting the number of projects related to circularity would for instance be a good indicator, or measuring the percentage of the business that runs a circular business model. These are still indicators that focus primarily on single enterprises. Not surprisingly, one of the interviewees wondered if any indicators could be designed that can measure collaboration, whether it is good or bad, efficient or inefficient. From the interviews, it became clear that no precise indicators exist that measure the whole performance of the value chain.

4.2.3 Appropriate staff

In the interviews it was asked what competences or characteristics employees are required to have in collaborative partnerships for circularity. In Table 5, the findings are presented, after which they are elaborated on. The number in each cell refers to how many times it has been mentioned.

Table 5: Typical competences or characteristics of employees working in partnerships for circularity

Entrepreneurial [5]
Open-minded [5]
Creative [5]
Visionary [5]
Altruistic [3]
Leadership [3]
Flexible [2]
Technical Expertise [2]
Structured [2]
Trustworthy [1]
Analytical [1]
Honesty [1]

First and foremost, employees need to have an entrepreneurial mind-set, which means that they have the courage to take risks without any fear and have the ability to act instead of just talk. Then, they need to be visionary, especially the people at the top of the hierarchy. Top-managers need to envision a future state and be a guide for the rest of the employees in the transformation. Strong leadership is necessary, but without it becoming too strict. Sufficient know-how (i.e. technological expertise) is required from the people that coordinate the value chain in particular. It was further required from employees to be open-minded to new ideas and the opinions of others, followed by a flexible attitude to adjust to new plans. The flexibility of changing plans needs to be balanced with a structured way of project planning. Next, creative people are required for innovation and analytical people for seeing the ‘bigger picture’, in order to make the right matches between people and companies. Of course, honesty is a boundary condition for creating trust.

4.2.4 Financial resources

As was identified in the theory chapter, the implementation of circularity will be slow and difficult without sufficient funds. One interviewee explained that many projects fail due to a lack of financial resources. He continued that top managers must be committed to invest money in projects. In partnership agreements, it was found that more money can be collected. Although circular business cases are definitely deemed profitable, it requires time to make that happen. For instance, in one of the partnerships it was expected that only after three to five years profit could be generated. One interviewee emphasized the fact that businesses must try to find real launching customers in order to solve some of the financial difficulties. This would also help them with receiving credit from a bank. Indeed, a few of the interviewees expressed the difficulties that they encountered with this. That might have been the reason why at Philips an internal fund was created, similar to how in Keiretsu an internal bank exists in support of the financial services of other companies. Despite this observation, banks are currently figuring out how they can cope with the new demands.

4.3. Managerial capabilities

In the theory chapter, four capabilities were described that are important for the management of a circular value chain. These are: collaboration, coordination, integration and stabilization. In this section the findings about these capabilities are presented.

- Collaboration
- Coordination
- Integration
- Stabilization

4.3.1 Collaboration

The interviewees were asked to give their view on collaboration capability within the value chain. It was found that generally two factors determine the overall success of collaboration, which are multiplication and reciprocity. One of the interviewees described it as a combination of making use of the knowledge residing in the partnership, the partnership's ability to put it into practice and the ability of partners to grant each other the business.

The first condition, multiplication, refers to the identification of the benefits of working together: what else, or more, can the partnership achieve by means of collaborating. A large consensus was found in the interviews that with collaboration within the value chain it is possible to do more or create additional value. Without a multiplication factor parties have no incentive to collaborate. The added value of collaboration can lie in simple facts, such as new ideas being generated, becoming financially stronger, or being able to influence legislation easier. With respect to a higher innovativeness, one interviewee put it as follows: *"We don't have a monopoly on wisdom. By collaborating with other parties each with their own expertise, new ideas will be born"*. This was confirmed in several other interviews.

The second condition, reciprocity, means a balance in what people bring and take. One interviewee indicated that only if all parties are able to add value, a partnership is able to multiply. In essence, reciprocity implies a fair distribution of the added value throughout the entire value chain. He added: *"If you are not willing to share, you cannot multiply"*. It is the ability to grant partners as much as the company, referring back to the altruistic characteristic of the staff. Ideally, companies align their self-interest with the collective interest of the partnership, as he further explained: *"Everybody thinks they are collaborating in the interest of the company, but when the collaboration is in the interest of the company, then it is something entirely different"*. He thought to make collaboration succeed, the collective interest has to come first and the self-interest of partners second. An example that pictures this idea well, came from a second interviewee. He explained that when he was working in Japan for Toyota, problems appeared at the supplier factories. Instead of Toyota creating a lawsuit or asking for compensation, a team of employees visited the factories and provided help. This example is what he understood by true collaboration. He further said: *"The question should not be what I can do for you, but should be what do you need from me?"* Another interviewee said that in comparison to a linear supply chain, in which a company only communicates with its direct suppliers and customers, a company must now listen consciously to the needs of those parties that are not directly connected. One interviewee further explained: *"The crux of collaboration is to find out what the opportunities and benefits are for your partners (...) parties will realize soon enough when they are being used solely for the benefits of the other"*. He continued that it can be a difficult task. When they sent pieces of clothing to a recycling company and asked for their recyclability, they discovered that their company already needed the recycling company more than the other way around. For them, this meant more effort had to be put into explaining the benefits for the recycler. Another interviewee called it a mind-set of taking care of all the different interests: *"It is massaging and kneading, paying attention to the interest of one and then the other"*. It could therefore be observed that listening carefully, and contributing to the needs of others, is a crucial element of reciprocity.

4.3.2 Coordination

As was identified previously in the theory chapter, three major flows have to be coordinated in the value chain: the material flow, the financial flow and the information flow. As the coordination of the financial flow and information flow still remained unexplored, the findings that are described next will deal with these two topics.

The interviewees were not always clear about how the financial flow has to be coordinated along the value chain. It sometimes did not provide more information than remarks like ‘an honest distribution’, as the meaning of ‘honest’ stayed vague. The difficulty could lie in the fact that many companies still behave competitively with the margins they keep for themselves, the mystery of what something truly costs, or the difference between people in estimating the value of things. The interviewees expressed that it is a difficult topic. Once a collaboration enters the phase of price negotiations, the good relationships become endangered. Despite the described haziness, two methods were identified that provide valuable insights on how the financial flow is to be coordinated along the value chain. In the first method, from now on referred to as the ‘outside-in’ method, each party continues to rely on themselves financially and signs a preferred supplier or exclusivity contract, prohibiting the supply of the same material, components or products to other parties. They subsequently decide for themselves what their margins are, but they are permeated with the determinative price of alternative (linear) goods. This means that partners are not permitted to ask for extremely high margins, because adding those will result in the product becoming too expensive, and will thus not be sold anymore, making the entire chain lose. When parties negotiate about their prices, they eventually reach a point when the product becomes marketable. The interviewee that explained this method called it a ‘self-adjusting process’. Open-book accounting was found unnecessary in this approach. Arguably, with some exceptions to be made regarding the extend of collaboration, this method is most aligned with how economy currently functions. The second ‘inside-out’ method assumes that the total revenue of the value chain is derived from the multiplication of the final price of the complete product and the amount of sales. This total revenue is in turn distributed among the members of the value chain, aided by open-book accounting. It is allocated equivalent to the costs made by respective partners. To avoid conflicts, it may require the involvement of an independent mediator. The idea of having an external agency partially taking over the accountancy was not found to be a major problem for some of them. In this method, partners can also decide to deposit part of the total revenue in a centrally administered innovation fund. Any required investments in any part of the value chain can subsequently be financed from this fund, and the returns can flow back into the fund.

Regarding the coordination of the information flow, sufficient communication throughout the value chain was found vital for the overall performance. It boosts innovation, builds trust, and retains support. One interviewee even had the special task of setting up a communication program for the benefit of information sharing. This shows how crucial it is that information becomes disseminated. Another interviewee noticed that partners can never communicate too much. In general, for implementing circularity within the value chain, the type of information that needs to be shared is about the design, the production and recoverability of products. This results in a comprehensive package of information, created with the contributions of all partners:

- Customers will express their demands.
- Retailers will communicate these demands.
- Designers will be responsible for translating these demands into new designs.
- Manufacturers will translate these designs into physical products.
- Suppliers of subassemblies will need to know how this affects the production of their supplies.
- Repair centres will communicate about how these products become easy to repair.
- Refurbishers and remanufacturers will provide input on the reusability of the products and components.
- Recyclers will need to provide information about the recyclability.

As can be seen, in a circular value chain information exchange is a holistic process, by taking note of all the interdependencies of the information provided by every party, and how this effects the overall outcome. It requires the belief that all parties have something useful to say.

Despite the observation that communication must take place in an integrated manner, it was found that much of the communication still happens bilaterally by phone or e-mail. More advanced communication technologies, such as online group conversations or cloud computing were sometimes in place, but were not always used to their full potential. One interviewee noticed that the use of these technologies ultimately depends on the people's ability to work with them.

Regarding the topic of intellectual property within a circular value chain, one interviewee stated that each party received a financial compensation for the knowledge they put in, apart from the money that they received for operating machinery. This was done to foster information sharing. In many cases, the intellectual property that partners provided, remained within the partnership by means of NDAs. They were signed to prevent confidential information leakage to competitors outside the partnership. Often, the knowledge that was being developed within the partnership, became the property of the partnership as a whole. The interviewees explained that after NDAs had been signed, information sharing was enhanced substantially. Companies are still willing to share confidential information with parties outside the partnership, but only when they receive a financial compensation for the amount of research and development they had put in.

4.3.3 Integration

As discussed in the theory chapter, integration takes place on many levels and is seen as a key capability for circular value chain management. Interviewees expressed that integration happen naturally, or 'organically'. One of them said: *"It is a gradual process which could take five years or more (...) After this period, we may reach the feeling that we operate a joint venture and could celebrate that"*. They explained that integration cannot be forced right from the beginning. Generally, in a partnership companies can find out if they match, and can eventually create a merger or a joint venture. In most cases a joint venture will be created, because companies often have other activities and processes in place, ruling out a complete merger. One interviewee noticed that the possibility of integrating other parts of the value chain depends on the company's size. He said that a large stable enterprise with a large quantity of sales would have the economies of scale in favour, to organise such a value cycle on their own. Another interviewee noticed that especially for larger companies that are listed it is difficult to create, or to transform into new entities.

Furthermore, it became clear that there are both arguments in favour and against the idea of integrating all value chain activities within a single virtual organisation. The arguments mentioned in favour are the ability to cut on margins, better control on quality, or the simple fact that all employees represent one and the same interest. Interestingly, one of the interviewees already addressed her partners' employees as 'colleagues'. Arguments against more integration are the loss of separate identities and expertise, the fear that it would become a bureaucratic system, or that it would create too much interdependency. By too much interdependency was understood that when people at one side of the value cycle make heavy mistakes, the people on the other side would incur the damage. However, this might already be the case for the value chains that exist today. Another argument against full integration is that the market is a very dynamic place: what customers want today may not be the things they desire tomorrow. One interviewee had her doubts if such an integrated value chain is capable of dealing with these changes. Indeed, working from separate businesses leaves room for businesses that are found necessary to grow and businesses that are found redundant to starve.

4.3.4 Stabilization

Before stabilization takes place, the value chain needs a certain amount of absorptive and adaptive capacity. In the interviews, the importance of having an absorptive capacity became very clear. A few

quotes from the interviews illustrate this: *"You make use of each other's knowledge", "You accept that somebody else may know better", "You learn in an early phase what each other's strengths are" and "be open-minded to the opinion of other people"*. With regard to adaptive capacity, interviewees said that partners need the ability to change their plans when things do not turn out as expected. One interviewee explained how things were usually set in stone, but since they perceived this as impossible, they had built in many degrees of freedom. Their partners were given a lot of freedom to find the best route from A to B. Learning by doing, was found very important. Since partnerships still lack certain resources to manage the entire product value cycle, the interviewees made clear that their partnerships were always open to new allies, given the terms and conditions that new partners would follow the principles of a circular economy. Therefore, a closed material loop does not necessarily imply a closed system. To avoid conflicts, interviewees expressed that their partners had the freedom to make errors. A culture in which failing is acceptable, was deemed very important. One interviewee explained ironically: *"We tell our people that the only thing they can do wrong is being inactive, so not choosing a route to take. If they have turned right, and they realize that they should have turned left, they know what the right route is, and nobody is allowed to say 'What took you so long?' "*. This type of flexibility is important, because companies enter unexplored territory when they construct a circular value chain. In the cases in which conflicts appeared, interviewees expressed that their colleagues had a strong will to solve them. The persistence of people was also found to be important. Projects can take many years, as one interviewee explained that they kept pulling on a project for more than seven years to make it succeed, where others would have given up. The theory further indicated that simple value chains are more stable than complex value chains. When the number of parties increases, more relationships need to be managed, which makes the coordination of the material-, information- and financial flow too complicated. One of the interviewees confirmed this when he explained how he once worked in a partnership which comprised fifteen to twenty parties and called it 'a drama'. He felt that only few parties were committed to make the project succeed and the rest enjoyed freeriding, so he continued to keep it 'low-profile'. Keeping it simple may also be achieved by focusing on a single or a limited amount of products, as one other partnership did.

5. Discussion

So far, the relevance and meaning of all the identified inter-organisational resources and capabilities of a circular value chain have been explored in practice. In this chapter, the important findings will be summarized in terms of new insights in relation to existing theory. For each domain of the framework the elements will be discussed in the same order as they were dealt with in the chapters on the theory and findings. In each section the main implications for the value chain will be discussed, answering the main research question of how a supply chain can be organised, operated, and managed in line with circular economy principles. Finally, some general remarks will be made, the limitations of this research will be discussed, and recommendations will be made for business, researchers and policy makers.

5.1 Organisational boundary conditions

Regarding the joint identity, it cannot be determined by one or a few elements. In fact, numerous elements influence the creation of a joint identity, but it seems that having the same norms and values lays the foundation for a joint identity. In line with this observation, another study revealed that pioneering companies in a circular economy are innovating from a shared sense of purpose and a shared set of values (Forum of the Future, n.d.). This indicates that in future, partners will reflect more upon what they have in common, rather than upon their differences. The interviews further revealed that partners were more comfortable when the shared identity was not a closed dogma, but was open for new insights of their own. However, the extent of openness remains arbitrary, because formalization can also help partners develop a stronger joint identity. To meet the wish for sufficient openness, formalization may therefore not be binding, so objectives can be revised. In doing so, the established shared values can still be protected. Until now, existing literature has merely indicated the importance of a cultural identity for the survival of a single organisation (Carrillo & Gromb, 2007), whereas this research shows that a cultural identity is also important for the survival of partnerships.

It was further seen that partners need to communicate openly about each other's self-interest. This is necessary to avoid future conflicts. If this is taken one step further, one might wonder what open communication about each other's self-interest really achieves. On the one hand, it can be approached as purely a process of aligning self-interest. This would mean that any differences between partners become blurred, and a single collective interest is created. In this case, self-interest becomes non-existent, confirmed by one interviewee who stated that the collective interest has to become a company's self-interest. This finding elaborates on the existing theory which so far merely assumed that self-interest continues to exist (Jonker et al., 2013). On the other hand, self-interest may indeed never disappear and can clarify why parties have become part of the partnership, gauging people's drivers and their commitment. This latter approach can give a clearer image of whether all self-interest is sufficiently taken into account in the partnership's future activities. Taking into consideration both perspectives on self-interest, they need to be evaluated carefully when communication is taking place about the objectives of the partnership.

All partners in a circular value chain are advised to define their roles in a sharp and distinctive manner, in order to avoid overlapping activities which can result in conflicts. Some roles are however overlapping and conflicting by nature, especially the ones of parties involved in the take-back chain (e.g. repair, remanufacturing, recycling). Surprisingly, this issue was never taken up seriously in existing theory. Of course, a situation in which partners compete for products and material to make money is never desired. Still, parties from all the different take-back industries need to be involved for optimal value decisions. That is why this research indicated that especially in these areas integration has to take place. Repair centres, remanufacturers and recyclers will need to unite as one party in the value chain, with the primary aim of restoring product-embodied values with as little value destruction as possible. Recycling will then only occur when products have become fully emotionally obsolete and when repair or remanufacturing is no longer possible.

Sufficient safeguards need to be installed to minimize the chance of failure and opportunism. The use of formal agreements was seen to be an important measure for achieving this. The existing theory

indicated that in large partnerships they become increasingly important (García-Canal et al., 2003). However, the findings have shown that they can also have a diminishing effect on pre-existing trust. In addition, Dyer & Singh (1998) have also revealed they can be detrimental to the opportunities for new value creation. In a circular value chain, companies therefore need to reflect critically upon their use of contracts.

As could be further seen from the interviews, there are three types of transparency: operational transparency, financial transparency and transparency on each other's roles and interests. Such a classification has not been made before in the debate and theory on circular economy, and can help managers improve their communication efforts.

In a collaborative structure, it was found important that each company has the power to influence the decision-making. However, companies that invest more in the partnership naturally expect to have a greater say in the process, whereas other companies can bring in other, more intangible resources. The chance of a conflict in these situations can be high. In order to eliminate that possibility, partners in the value chain are advised to make precise agreements on how much decision power each of them holds, and in what manner decisions are being made. This can, of course, take a variety of forms, such as a general policy in which each company has its own vote, or a special policy of allocating decision power according to a partner's input.

In existing literature on supply chain management, the customer has always enjoyed a focal position (Sweeney et al., 2015). However, except for a faster delivery time, this research has revealed little about how customer satisfaction is in fact better fulfilled. This research has shown that in a circular economy, many tangible customer benefits can be obtained. As a matter of fact, in service-oriented business models the direct interests of customers are completely aligned with those of providers. Both parties benefit from product endurance and quality. Surprisingly, from the interviews it was found that customer satisfaction in a circular economy was not always perceived to be better than in the linear economy. This misconception, already identified in the theory, needs to be resolved, so that it becomes another potential driver for businesses to implement circular principles. Despite the many opportunities for improving customer satisfaction, one major caveat can be identified. Ideally, in a service-oriented business model a product lasts forever, requires no maintenance, and provides customer value indefinitely. Yet it remains unclear for how long customers are willing to pay for such services. They may become frustrated about the fact that no longer any labour needs to be invested during the product's lifetime, which would have justified their payments. In this scenario, planned obsolescence may therefore never be completely designed out. A lower price for the provided service might soothe some of the frustrations, but this will affect the company's chance of survival. It can thus be remarked that businesses with service-oriented models are advised to reflect critically upon their prices, to guarantee their own survival, and to ensure customer demands are satisfied.

When users really play an important role in circular value chains, as how pioneers portray them to have, a better understanding is required of how exactly they become integrated in the value chain's architecture and what their role exactly is. Once communities of consumers and users and their interests are similarly taken into account to the ones of other parties along the value chain, it may be necessary for businesses to step up their communication practices with these communities. Lacy & Rutqvist (2015) already stressed the importance of so-called 'social technologies' to improve this communication, but in order to better streamline this information, future value chains may want to construct special 'user panels' in their architectures. Such user panels would consist of people representing the user communities, and may even get paid for the work they do.

5.2 Operational resources

Besides building the proper boundary conditions, partners acquaint themselves with the technologies and tools to implement circularity. It was found that innovation of engineering and digital technologies can substantially transform the way current value chains are operating. While engineering

technologies enable material loops to be closed, digital technologies will benefit the relationships among partners and make the management of the value chain easier. Recalling the concept of the fourth industrial revolution, value chains will become 'virtual' in the future when people, computers, products, components, materials, machinery and other assets are connected over the internet. In this transformation, products will become track and traceable (Lacy & Rutqvist, 2015). This research has shown that 'track and trace' does not always have to rely upon new technologies. It may also be organised with conventional production runs, serial numbers, or lease contracts. However, when products also become shared, borrowed, hired and exchanged between users in the market, for the purpose of value exploitation, this would become problematic. Attaching a tracking asset to the product is therefore unavoidable for companies that develop a sharing platform in their business model. Companies could also specify their agreements with users, either prohibiting the exchange of products, or granting permission with some terms and conditions. In the end, products may never become lost anymore when value chains have built a proper coordination capability.

5.3 Managerial capabilities

Four capabilities were identified to be relevant for an effective utilization of the integrated resources, which are collaboration, coordination, integration and stabilization. In the theory chapter, it was already observed that collaboration in the value chain can result in significant advantages for its performance, but in which situations collaboration initiatives are being developed remained unclear. By looking at the data from this research, it could be observed that collaboration capability is created when partners can define explicitly what extra value is created when they work together. This resembles the concept of a 'relational rent', defined by Dyer & Singh (1998) as *"a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners"* (p. 662). In addition to identifying this value, it was found that partners must find a way to share or distribute it. In short, multiplication and reciprocity are crucial elements in collaboration capability. Distribution of the value usually takes place in the form of consecutive margins in the value chain by means of negotiation, which was referred to as the 'outside-in' method. However, profit may also be distributed in a more centralized manner, which was called the 'inside-out' method.

Despite the call for more collaboration within value chains, a circular economy will not be realised effectively if a company's collaboration efforts do not extend beyond their current value chains. Pioneers have shown great opportunity in 'cross-sectoral' collaboration, in which the 'waste' of one value chain becomes the input for another. For instance, a ketchup maker is now working with a car manufacturer to create bio-based car components from tomato skins, a by-product from its production process. A second example is the use of a resin in carpet tiles, which was previously used in laminated safety glass from cars. Besides, tenacious technological problems that currently exist in value chains may get resolved with cross-sectoral collaboration. For instance, a better cutting machine for carpet tiles was found from the aviation industry, where the machine was previously only used to cut aircraft wings. This reduced the cutting waste by eighty percent. In a circular economy, cross-sectoral collaboration is therefore as important as collaboration within the existing value chain, but they do serve different purposes. Although opportunities for a higher performance can be found in both types, cross-sectoral collaboration mostly explores these new opportunities, while value chain collaboration is mostly necessary for managing and improving the status quo and to explore any opportunities with the existing knowledge of value chain partners. Cross-sectoral collaboration therefore has a more explorative character than value chain collaboration.

5.4 General remarks

Some of the identified boundary conditions are interrelated among themselves, or with the managerial capabilities, in causal relationships or in self-reinforcing feedback loops. Most notably, these elements include trust, transparency, parties' interest, support and commitment from the boundary conditions domain, and collaboration and coordination from the managerial capabilities domain. Other relations

were found between formal agreements and trust, or between the people's commitment and stabilization capability. In many of these interrelations, the presence of trust is of great importance. Once sufficient trust is built, the partnership will enter a phase of self-reinforcing feedback loops, strengthening the relationships among partners, which can ultimately result in the transformation of the value chain. This finding is very much in line with existing theory, which indicated that trust is the lubricant of social interaction in the final form of collaboration (Gold et al., 2010).

While some resources have proven themselves as highly important (e.g. a joint identity, trust, transparency, support from top-management), and can therefore be seen as organisational boundary conditions for a circular value chain, other resources are perceived of lesser importance (e.g. circularity enabling technologies, a measurement system, appropriate staff), and therefore fall in the domain of operational resources. In addition, a set of managerial capabilities is needed to ensure other resources become utilized.

Comparing the scientific articles with the data from the interviews and industrial reports, it could be observed that in the debate on circular economy there is an inconsistent use of the term 'circular value chain' and its possible variants. In literature, scientists mostly refer to the concept as the 'reverse supply chain' or 'closed-loop supply chain'. The reason might be that authors align with the abundant supply chain management literature. In the business environment in which a circular economy has become a known concept, the terms 'circular value chain' and occasionally 'value cycle' seem to appear. Other people refer to it as 'supply circles' or 'circular production chains', and even 'value networks' or 'value systems' seem to appear. This inconsistent use may of course be expected from a field that is in development, but it can create a lot of confusion when people talk about a circular economy with what they have in mind in relation to what others have in mind. Future research can investigate what the similarities and differences are between the definitions of those terms. In this thesis, a clear choice has been made to use 'circular value chain', for three reasons. First, it contains the notion of 'circularity'. By now, it should be clear that this means a lot more than simple recycling. Second, it contains the notion of 'value'. From many of the data sources it could be observed that in a circular economy 'value' and all its possible connotations deserve ample attention. Especially, a closer look has to be taken at how we value products. Are they merely there for the use of the customer, or are they integral objects to be maintained? Maybe products need to be looked upon in a similar fashion as how people perceive works of art, in which it is very common to preserve the objects in their original state for as long as possible. In line with this thought, Turntoo² proposed a universal declaration of material rights. For some this may sound absurd, but it does reveal that our current mind-set to products and materials is being challenged. The final reason why in thesis the term 'circular value chain' is used is because it contains the notion of a 'chain', referring to the fact that it consists of 'links', in which each link is representing a single party. The 'value cycle' is almost synonymous with the circular value chain, but as explained in the section on integration, it may be worthwhile to distinguish the 'cycle' from the 'chain' as an even more holistic and integrated concept, as though there is only one entity exercising control on the product value cycle. Possibly in the future, such cycles will begin to appear more frequently when the boundaries of businesses have been redrawn. Finally, the use of 'supply chain' is not recommended, because from a historical perspective it is too much connected with just the supply of goods to the customer and it rarely involves a take-back chain.

5.5 Limitations of this research

Due to a limited amount of time for each interview and the broad scope of interview questions, it was not always possible to discuss all resources and capabilities. Some of the findings are therefore not quantitatively supported. The scope of this research is further limited to the topic of how circular value chains are organised, operated and managed in the most general sense. It did not for instance address

² Turntoo is a company located in the Netherlands which advocates and consults businesses on service-oriented business models to make a circular economy come true. In collaboration with Philips, it introduced the 'pay-per-lux' model.

any technological problems that companies can encounter in their efforts of improving resource utilization. Further research can investigate what precise technologies are required to effectively close material loops for the wide range of existing products.

Furthermore, the empirical findings on two managerial capabilities, integration and stabilization, are limited. Companies have only just begun to collaborate and have never thought of a merger or the creation of a joint venture. It became evident that companies struggle with, or are not used to the idea of full integration, where all parties would become one extended virtual enterprise. Despite the advantages of such mergers or joint ventures, the effects on interdependencies and administration need to be studied more carefully. This research could also investigate how these enterprises will adhere to the inertia principle. Regarding stabilization capability, no conclusions could be made on a value chain's resilience and robustness to disruptions in the supply and demand of materials in the context of a circular economy.

5.6 Recommendations to business

Implementing circularity in the value chain is a continuous process of improvement, something consultants usually refer to as the 'plan, do, check, act-cycle' (Deming, 1952). Still, some recommendations can be made for guiding partners in their endeavours. It is recommended that they first check their compliance with the organisational boundary conditions and address any issues related to that. Once partners are satisfied with the level by which they are fulfilled, they can look for the missing operational resources. In the meantime, managers are advised to take all the capabilities into account for optimal use of their resources. More concrete recommendations for business are made in the form of a step-by-step guide in their journey for organising, operating and managing a circular value chain. It can be found in Appendix C.

5.7 Recommendations to researchers

Most of the value chains of today work with sophisticated and narrowly-defined contracts, and rarely a value chain is organised solely based on trust. It would thus be interesting to do further research on this topic, but it would require a case study on a partnership's pledge to work with less contracts to measure the differences in performance. One experiment could be the shift from bilateral supply contracts in value chains to a centralized trust-based accountancy of material and financial distribution. Further research can also deal with the question what methods exist or can be developed to determine how total profit can be allocated and distributed according to a partner's characteristics, such as installed machinery and its age for a return on investment, energy costs, employee costs, or intellectual property.

High levels of transparency have a positive effect on the amount of trust and enhances coordination capability, but partners are not always, or initially willing to share all information with each other. They may fear knowledge spillovers to competitors or that information becomes abused by their partners. A better understanding is required of what information needs to be shared for the sake of circularity, and what arguments are raised against it. One of the clearest calls from pioneers is the disclosure of the exact amounts and types of materials in products, in the form of product passports. However, a topic which has often gone unremarked is the disclosure of financial information. This thesis has shown that sharing this information can be beneficial for creating new business cases, or to coordinate a fair distribution of profits along the value chain. Further research can elaborate on this topic.

This thesis has shown that different tools are being used by businesses to measure circularity, but it remains unclear what their applicability is in measuring circularity. Peruzzini et al. (2013) already observed that LCA needs to be adapted in a way so it can also assess the impact of extended services. Research institute TNO in the Netherlands is now collaborating with a manufacturer of furniture, for the development of an improved LCA tool, so that it can account for different scenarios. It is evident that the contemporary tools are not entirely suited for measuring circularity and thus this needs to be further researched. So far, it seems that the Material Circularity Indicator tool from the Ellen

MacArthur Foundation is the simplest, yet appropriate tool for measuring the circularity of the entire value chain, but the amount of indicators developed by this tool is still limited. In general, it seems that performance measurement of circularity is still a topic that should be further researched, especially in the context of a value chain.

Finally, the concepts of value preservation, exploitation and restoration introduce a fundamental discussion about the macroeconomics of a circular economy. It raises the question whether even the most innovative product-service models are able to capture enough of the potential circular value, so that it will outcompete linear value creation. From a meta point of view, value preservation, exploitation and restoration has to be rewarded equally if not more than linear value creation, otherwise a turning point in the economy may never be achieved. Economic research is thus required investigating how the preservation, exploitation and restoration of product-embodied values can be quantified and incentivized properly.

5.8 Recommendations to policy makers

Taking into account that companies operate in a world of rules and incentives set by governments, policies and legislation must constantly be evaluated and judged upon their alignment with the principles of the circular economy.

In the renewed ‘Circular Economy package’ of the European Commission new measures are taken regarding circular design, instead of solely focusing on waste (Euractiv, 2015). Still, many obstacles in legislation remain to be solved, such as the legal ascription of some resources as ‘waste’. In the Netherlands for instance, paint residues were labelled as waste and were prohibited to be recycled into new paint. Furthermore, the extraction of resources from nature remains untaxed, whereas labour is still being taxed, inhibiting the repair and remanufacturing of products. To realize a circular economy, things that are renewable (e.g. labour, solar and wind energy) remain untaxed, and things that are non-renewable (e.g. fossil fuels, minerals) become taxed. This topic is seldom a subject of current political agendas of governments.

In an early phase of bringing a new product or service in market, certification might be a critical boundary condition for companies to earn a customer’s trust. However, the interviewees expressed that certification is a costly expenditure and is not directly benefiting the customer. If certification was being rewarded properly, a win-win situation could be created for both the companies and the customers. This means that policy makers are advised to investigate how they can reduce certification costs, and how they can incentivize people’s behaviour to buy circular products or services (e.g. a discount on VAT). At the same time, there is a risk of ignoring companies that make use of operational transparency instead of certification to demonstrate their circularity. That is why certification should ideally not be paid for.

Furthermore, many companies still operate in worlds of secrecy, shown by news articles covering fraud and scams, or journalists who are kept outside a business’ factory doors. When new research would prove that the nondisclosure of particular information is ever found to slow the transition towards a circular economy, governments may need to enforce new legislation on transparency standards. Therefore, this thesis recommends policy makers to find the importance of these issues and create necessary incentives to realize a circular economy.

6. Conclusion

In the beginning of this thesis it was explained why a transition towards a circular economy is necessary for the well-functioning of society. The current economy is characterized by an unlimited extraction of natural resources, short lifecycles of products, and negative externalities residing in the disposal of these products. Adopting a circular economy will alter this unsustainable pattern of endless production and consumption. Previous research is focused on describing the existing obstacles in the current organisation of supply chains. This thesis has contributed to understanding and solving some of those difficulties. It has also made a contribution to the vocabulary of researchers and people from business, for a better understanding of the definitions and concepts related to a circular economy. Lastly, this thesis has made a contribution to the research on inter-organisational resources and capabilities, by looking at them from a circular economy point of view, while previously this has only been done for supply chain management.

The main research question which this thesis addressed was how a supply chain can be organised, operated and managed, so that it would follow the principles of a circular economy. A more careful study of those principles, led to the conclusion that businesses must manage entire 'product value cycles', instead of contemporary product lifecycles. The traditional and one-dimensional way of value creation in the manufacturing of products must be extended with the preservation, exploitation and restoration of this value. Thus, the assumption that in a circular economy companies are only part of a supply chain, which covers just a part of the product value cycle, can no longer be justified. Future research is advised to focus on answering the question how preserved, exploited and restored product-embodied value can be quantified and incentivized, in order to realize a circular economy.

Current businesses have only just begun to capture the potential 'circular value'. They still lack the resources to operate entire product value cycles, while these can reside in the realms of other companies. An inter-organisational perspective is therefore fundamental to the transformation of supply chains. Companies that can identify and capture their synergies with other companies in partnerships are more futureproof. In this process, circular value chains will emerge. To further answer the main research question of how these new systems can be organised, operated and managed, this thesis identified and explored their inter-organisational resources and capabilities.

Some of the more intangible resources are perceived as organisational boundary conditions for circularity. These include a joint identity, parties' interest, support and commitment, safeguards against failure and opportunism, transparency, a collaborative structure, and the satisfaction of customer demands. Other resources support the implementation of circularity and covered the operational resources. These include circularity enabling technologies, a measurement system, appropriate staff and financial resources. Finally, four managerial capabilities have been identified that ensure other resources are utilized, and comprise collaboration, coordination, integration and stabilization. It is seen that systems thinking, defined as looking at the interrelations of the parts and their effect on the whole, is fundamental in understanding how inter-organisational resources and capabilities interplay for creating, operating and managing a circular value chain. Many of the resources and capabilities are linked causally or in self-reinforcing feedback loops. Managers must therefore be cautious in not becoming too obsessed with single resources, causing them to forget the relevance and inter-relationship with other resources.

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Appendix

A The history of the circular economy concept

The concept of a circular economy draws upon several schools of thought, most notably Cradle to Cradle, Performance Economy, Biomimicry, Industrial Ecology, Blue Economy and Regenerative Design (Ellen MacArthur Foundation, n.d.). In a research report of 1976, Walter Stahel, envisioned an economy of loops. He came up with the expression Cradle to Cradle and can be considered as one of the founders of the circular economy concept. He also promoted the notion of a performance-based economy, insisting on selling services rather than products. Then in 1989, Robert Frosch and Nicholas E. Gallopoulos wondered if our industrial system could behave like an ecosystem, in which the remainders of every living organism is the resource for another organism. The corresponding scientific field has grown quickly, shown by the amount of articles that have been published in the Journal of Industrial Ecology. In 1997 the book 'Biomimicry: Innovation Inspired by Nature' was written by scientist Janine Benyus. Biomimicry is the science of imitating nature to solve human problems. Besides, in nature waste does not exist. In 2002, William McDonough and Michael Braungart published a book about Cradle to Cradle (C2C) design. According to their ideas, products have to be designed with three principles in mind: waste equals food, use renewable energy and celebrate diversity. Lastly, the Blue Economy, initiated by the Belgian businessman Gunther Pauli, states that resources must be used in cascading systems and the waste of one product becomes the input to create a new cash flow.

B Obstacles in a transition towards a circular economy

Many obstacles in a smooth transition towards a circular economy have been identified within some of the published reports (Ellen MacArthur Foundation, 2012; IMSA Amsterdam, 2013; Schoolderman, et al., 2013). They can be classified into institutional, financial, technological, organisational and societal obstacles. Institutional obstacles are related to the current governmental incentives for a linear economy, legislation that forces companies to compete and current insurance policies. Financial obstacles are, amongst others, large up-front investment costs, the fact that externalities are hardly taken into account, and the dominant short term agendas of shareholders. Some of the technological obstacles are linear technological lock-ins, a limited attention for the end-of-life phase in product design, or in some cases a compromised quality of recycled material. The organisational obstacles are dealt with in the main text. Finally, societal obstacles are the unwillingness of powerful players to cooperate, the unsuitability of GDP as an indicator for progress in society, and lack of public awareness.

C The step-by-step guide for organising a circular value chain

Step 1: Preparation

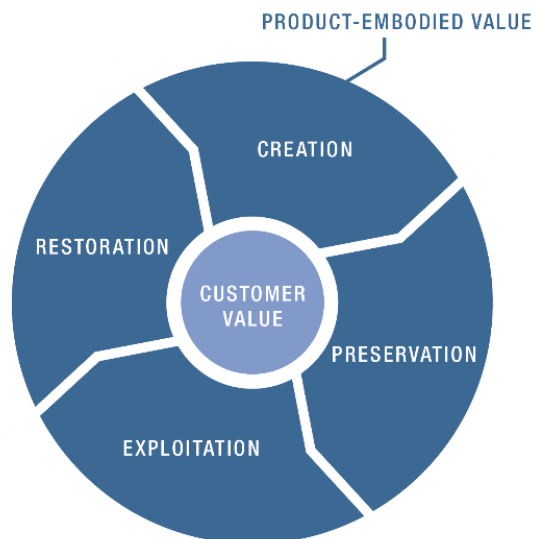
Determine your company's knowledge of the circular economy concept. Without a clear understanding of what the principles behold, you cannot assess what is wrong with the current state and therefore it is impossible to envision a future state.

Step 2: Kick-off

Map the current value chain of a single product you are operating in. Use tools like value stream mapping or analysis. Begin with a single and simple product, but when you get the hang of it, you can expand the model to complex products. Now get in contact with all the companies connected to this product and find out what each other's roles are in the value chain. Also, find out what the companies have in common and pay sufficient attention to that. When other companies are not familiar with the circular economy concept, try educating them.

Step 3: Assessment

Begin negotiating on the willingness of collaboration and try to discover each other's motives. Together identify what the missing resources are to manage the entire product value cycle. The product value cycle pictured bellow, guides you in assessing what activities are right for circularity and what activities are not.



Step 4: Concretize

Invoke a (formal) partnership agreement. Think about what resources are being shared and exchanged and how much decision power each party has. By now, partners must have envisioned a future state of the value chain and can translate this into concrete objectives. It must also have become clear if any self-interest continues to exist, which does not necessarily have to be a bad thing. Make sure everybody is heard, has the same vision in mind, and agrees on the partnership's objectives. Objectives may need to be revised from time to time.

Step 5: Identify

Now begin the process of information sharing in an integrated and holistic way, with a proper information system in place. Check for compliance with the elements in the framework below and identify points for improvement. When necessary, install exclusivity contracts and NDAs to foster information sharing, but keep in mind that informal relationships primarily based on trust hold greater opportunities for circular value creation.

ORGANISATIONAL BOUNDARY CONDITIONS			MANAGERIAL CAPABILITIES
<ul style="list-style-type: none">• Joint identity• Parties' self-interest, support and commitment	<ul style="list-style-type: none">• Safeguards against failure and opportunism• Transparency	<ul style="list-style-type: none">• Collaborative structure• Satisfaction of customer demands	
OPERATIONAL RESOURCES			
<ul style="list-style-type: none">• Circularity enabling technologies• Circularity measurement system	<ul style="list-style-type: none">• Appropriate staff• Financial resources		<ul style="list-style-type: none">• Collaboration• Coordination• Integration• Stabilization

Step 6: Improve

Solve the identified points for improvement, one by one. Listen to each other's needs carefully, educate staff, invest in research and development, design new products, experiment with service-oriented business models, develop a measurement system of tools and indicators, monitor progress, promote transparency, deliver upon promises, share in the profits being made, look for new partners and technologies, etcetera.

Step 7: Institutionalize

By now the changes to the value chain become institutionalized in the value chain's policies, procedures and routines. Reflect upon the advantages and disadvantages of a merger or creation of a joint venture, from where the operations can continue. From now on, the model can also be expanded to other products and thus the cycle can start again, beginning from step two.

D Overview of interviews

Name(s)	Title(s)	Organisation	Reference number
Andy Hall	Consultant	Sustainable Value Cycle Solutions	1
Anita de Wit	Initiator and co-founder	Reblend	2
Annemarie Piscaer	Designer	BlueCity010 and Studio Dust	3
Dorus Galama & Tom Leenders	Chief Executive Officers	Pelican House	4
Edward Pfeiffer	Senior consultant energy and resource recovery	Royal HaskoningDHV	5
Fabienne Goosens	Development Engineer	Attero	6
Florens Slob	Managing director Circularity Center & director business development and public affairs Van Gansewinkel	Circularity Center & Van Gansewinkel	7
Geanne van Arkel	Head of Sustainable Development	Interface	8
Gerald Naber	Vice President Sustainable Lending	ING	9
Iris van Wanrooij	Communications manager	Dutch aWEARness	10
Marc van Gerrevink	Member of board of directors	Van Gerrevink	11
Peter Bos	Chairman	Texperium	12
Ronald van Bommel	Chief Operational Officer	Cablean	13
Sander Jongerius	CSR manager	Groenendijk	14
Violeta Paginu	Junior consultant energy and resource recovery	Royal HaskoningDHV	15

E Standard interview questions

Collaboration:

What exactly do you understand by collaboration within a circular economy? *What are the benefits of collaboration for a circular economy? Why would you seek to collaborate with your value chain partners? How often do you see your partners? How do you promote collaboration within your organisation and with your partners?*

When do you feel part of this value chain wide partnership? *What does there need to be in place so everybody thinks they are part of the partnership?*

Can you rank and comment on the following list for what is best suited to create such a joint identity? *A brand, core product portfolio, shared objectives, shared codes of conducts, shared norms & values, a shared vision. Something else?*

Do you think that formalizing such aspects (putting it on paper/website/other communication channel) will strengthen the partnership? *Which of these aspects are more important and which are less important to formalize?*

How do you deal with all the different, perhaps conflicting, goals in the partnership? How do you try to align those? How do you make sure that the joint identity is not harmed when new partners, with their own objectives, join the alliance?

How do you promote a stable relationship with your partners?

Customer satisfaction:

Do you think customer demands are better satisfied in a circular value chain than in a traditional take-make-waste supply chain? *In what ways?*

Do you feel your customers are demanding more circular products? Or is this something they are hardly concerned with and the rationale of moving towards a circular economy only comes from the business?

Is there demand in your business to get your business or products certified for circularity (C2C certification), now or in a later stadium? *If yes, why do you want to get certified?*

Do you think current certification options are right for companies that strive for a circular economy, or is there a need for a new certification method in order to assess the circularity performance the value chain?

Safeguards against failure and opportunism

What (opportunistic) risks are there in circular value chain partnerships, if at all?

How do you minimize the chance people will behave opportunistic in the chain; taking advantage of another party's weaknesses? *In what way does trust play a role in this? How is this built?*

On what aspects do you think legal agreements (i.e. contracts) are required, if at all?

Do you think a partnership must fully rely upon trust, contracts or a combination of the two?

Transparency & Information exchange

What do you understand by being transparent? How can transparency benefit the development of a circular value chain?

What types of information should be exchanged in a circular value chain and what not? *Should all information be accessible? Why yes/not? What type of information is sensitive for opportunistic behaviour and what is not?*

Do you currently exchange this type of information with your partners on a regular basis? *How do you do this? How do you organise that this information exchange actually takes place and it doesn't fall with merely being transparent?*

Besides operational transparency (e.g. what is in the products, where is it located and in what quantity), do you think transparency on each other's revenues/financial flows/performance (i.e. open-book accounting) is required in a circular value chain? *Why not/yes?*

Collaborative structure

How would the organisational structure look like in a circular value chain? Would this be hierarchical or decentralized? Or democratic? What are the pros and cons of these forms of structures?

Can you think of any legal ownership structures that best support the transition towards circularity? (*e.g. cooperative, foundation, private company*)

How would the decision-process look like? *Do you think businesses with more employees, turnover or with higher investments in the project should have a greater say in decision-making processes? Or should there be a one company-one vote policy?*

In case you would differ the amount of influence companies have on the decision-making, how would this be allocated? *Should the amount of influence be weighted according to total turnover/employees, or perhaps the specific product life cycle stage turnover rates, or the business worth estimate (including earlier made investments)?*

Integration

Would it be better to merge with the various partners in the chain into a new single organisation, responsible for the full cyclic flow of materials, products, finance, and information? *What would the benefits of this be? Could you think of any benefits of operating in separate businesses? Is full integration even possible, considering the reality of most businesses participating in more than one supply chain?*

Circular business model

Under what logic, or business model, would businesses invest in circularity technologies (i.e. recycling technologies, better treatment, etc.)?

Do you think businesses still have a reason for this in situations when there is no direct scarcity of primary resources and with high prices. *So in cases when there are no common market principles that logically result in these investments or when they are not forced by law?*

In this regard, what do you think of product-service-systems, in which companies retain ownership of the products/materials?

Parties' interest, support and commitment

Do you have the feeling that partners in general have a tendency to hide their own interests?

How do you build the necessary support from your organisation, mid-management and top management? *In what way does top management have a role to play and other departments in the organisations?*

Do you experience resistance to change in your organisation? *How do you deal with it?*

What do you understand by a partner's commitment?

Circularity measurement system

Is there a need to monitor the progress made, why would that be? *How can you do that? Do you think KPI's are suit for this? Have you made any indicators together with your partners? Are your KPI's aligned with those of your partners? Do you think they should be?*

What tools or methods do you use or would help managers make the right decisions on where to put most effort/money in along the value chain for progressing towards circularity? *VSM/LCA/LCA/BOM? How can you make sure the results of such tools stay up to date? How often should a new assessment take place?*

Circularity enabling technologies

Do you miss particular circularity technologies, how would you make sure that you can find those? *Do you use any track and trace technology for your products with your partners? If yes, what exact technologies do you use?*

Coordination capability

How do you coordinate the material, information and financial flows of the chain? *How is the exchange of information, material or finance organised along your value chain?*

Innovation towards circularity costs money (e.g. the personnel wages who manage the value chain or investments in new technologies, etc.). *Imagine a situation when the returns are not directly earned back to those who have made the investments (e.g. new design for easier disassembly in later stage). How could you make sure such innovations still happen? Do you think a partnership innovation fund would help? Under which conditions are you willing to put money in this fund?*

Information system

Do you use some type of information and communication system with your partners? *Do they use the same system?*

What role does information technology have in circular economy?

Do you think that contemporary information technologies (e.g. excel, email) is sufficient or is there a need for more sophisticated technology in order to communicate properly with your partners?

Appropriate staff

What competences do you think the staff should possess which make the transition towards circularity possible? *How should leadership look like in a circular value chain?*