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Sustainable Value Creation in Closed-Loop Supply Chains:
A multi-case study analysis

Master's Thesis Internship –
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Abstract

The Circular Economy has come into the spotlight in recent years as a tool to address waste and the depletion of resources. With companies becoming more aware of the impacts they have on the environment and society, they are looking to recover their products and improve circularity within their supply chains. Many companies are working on developing "closed-loop supply chains" to address these concerns. The current literature has determined a comprehensive list of strategies, methods, and tools (i.e., factors) that enable sustainable value creation in closed-loop supply chains, but it is not yet clear how specific companies and sectors are addressing these factors. This exploratory study investigates how companies are addressing sustainable value creation in their closed-loop supply chains. To answer the research question, a comprehensive review of the current literature was undertaken and resulted in the development of a new theoretical model. To test the model and collect necessary data, this study took the approach of carrying out multiple case studies with companies that included the completion of a semi-structured interviews and a questionnaire. The results of the study indicate that companies are eager to create sustainable value in their closed-loop supply chains and are thus addressing multiple factors that enable sustainable value creation, including those that relate to Social/Relational, Operational, Technological, and Organizational aspects. Overall, it was found that factors that related to Social/Relational aspects were seen as most important for companies, especially the company strategy and collaboration with employees. In contrast, the companies rated Technological factors as least important but nevertheless felt that these factors must be addresses in future considerations. Furthermore, specific challenges were identified that can limit the efforts of sustainable value creation in closed-loop supply chains. Specific challenges related to the following: issues with funding, high investment costs for reverse logistics systems, price volatility of raw materials, employee and customer mindset about circularity, unclear regulations for recovery systems, and overcoming technical feasibility issues. The findings in this study provide a basis for determining which factors may lead to sustainable value creation in closed-loop supply chains of companies within multiple sectors. Suggestions for further research and recommendations have been developed for companies, organizations, and the government in order to build upon the findings of this study. In particular, it will be important to explore in depth what strategies need to be addressed to increase the level of sustainable value creation in the future.

Key Words:
Closed-loop Supply Chains, Circular Economy, Sustainable Value Creation, Factors that Enable Sustainable Value Creation

Executive Summary

This research has been carried out in part to give recommendations to companies as to enabling sustainable value creation in closed-loop supply chains. To achieve this, multiple interviews were carried out with companies within different sectors such as Electronics, Manufacturing/Machinery, Insulation/Carpet, Office Furniture, Material Handling/ Packaging and Startups. The results of the study can be summarized as follows: First of all, it was found that most companies participate in closed-loop supply chain recovery activities such as repair, reconditioning, remanufacturing, and recycling. However, there are certain sectors like startups that may develop new business models addressing the actual recovery process itself. Furthermore, circular business models were a main point of focus for companies, including product-service systems, buy-back or deposit programs, and maintenance and repair contracts for their products.

The completion of a questionnaire by all companies gave insight into the types of strategies, methods, and tools (i.e. factors) that each of the companies and sectors are addressing that enable sustainable value creation. These include factors that correspond to Social/Relational, Operational, Technological, and Organizational aspects. For most companies the Organizational factor category was found to be the most important in enabling sustainable value creation, especially the company strategy, collaboration with employees, and organizational alignment. Furthermore, the most important singular factor was seen to be collaboration with customers, a part of the Social/Relational category. Moreover, Social/Relational aspects that related to collaboration with multiple stakeholders such as suppliers, but also extending to inter-firm collaboration involving multiple parties was regarded as a key element. Additionally, Operational factors including product design and after-sales and recovery services were found to be critical in for enabling the recovery of products. Finally, Technological factors were found to be least important for the companies, but were determined to be essential for the future.

Based on the findings of this research, companies are addressing many different factors that enable sustainable value creation, but there is further room for improvement and development of recovery loops. The development of strategies to enable further sustainable value creation is also needed. Based on the findings of this study, specific recommendations can be made. First, it is advisable that companies continue to focus on social-related aspects of their companies such as employee engagement, and the development of leadership roles, in order to strategically align all functions within the organization and develop a mindset and culture based on circularity. Second, continued collaboration both inside and outside of the company, such as through inter-firm partnerships, is recommended. Moreover, collaborating with multiple stakeholders such as sector organizations, the community, and the government is advised. Third, it is recommended that companies continue to innovate and develop new technologies in order to improve product life-cycles and technologies that enable the recovery of products. Furthermore, they should build upon already existing circular business models and work to adopt new business strategies that will keep the products out of the recovery loops for as long as possible. Lastly, creating key indicators for both sustainability and circularity will be critical for companies to find a way to measure the progress and success of addressing specific factors.

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List of Abbreviations

C2C	Cradle-to-Cradle
CE	Circular Economy
CLSC	Closed-Loop Supply Chain
CSR	Corporate Social Responsibility
DBFMO	Design, Build, Finance, Maintain, and Operate
EPD	Environmental Product Declarations
ELV	End-of-Life Vehicle
EMF	Ellen MacArthur Foundation
EOL	End-of-Life
EPR	Extended Producer Responsibility
ERN	European Remanufacturing Network
ERP	Enterprise Resource Planning
EU	European Union
FR	France
FSC	Forward Supply Chain
GPS	Global Positioning System
HQ	Headquarters
IT	Information Technology
LCA	Life-Cycle Assessment
NGO	Non-Governmental Organization
NL	Netherlands
OEM	Original Equipment Manufacturer
OP	Operational
OPM	Original Product Manufacturer
OR	Organizational
PSS	Product-Service Systems
RBV	Resource-Based View
ResCoM	Resource Conservative Manufacturing
RFID	Radio-Frequency Identification
RSC	Reverse Supply Chain
SD	Sustainable Development
SR	Social/Relational
SVC	Sustainable Value Creation
TC	Technological
UK	United Kingdom
U.S.	United States
WEEE	Waste Electrical and Electronic Equipment directive

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1 Introduction

1.1 Societal Problem

Within the context of a linear system of "take-make-dispose," a product can contribute to significant social and environmental impacts during the stages of its lifecycle (EMF, 2014; Go, Wahab, & Hishamuddin, 2015; Jawahir, & Bradley, 2016). When products are no longer useful or at their End-of-Life (EOL), negative consequences may arise, such as increased pollution of the oceans and air, products ending up in a landfill, and the depletion of raw materials and critical resources (Gungor & Gupta, 1999; Mota, Gomes, Carvalho, & Barbosa-Povoa, 2015; Nielsen & Brunø, 2013). Increased need for more materials for infrastructure and product manufacturing puts a greater strain on certain communities, such as those in the developing countries in regard to the environmental and health impacts of extractive practices such as mining and fossil fuel production (EMF, 2015a; UNEP, 2011). With increased economic development and globalization businesses need to reconsider their current practices, by providing products for the market that avoid putting an extra burden on society and the environment (Kaebernick, Manmek, & Anityasari, 2006; Roscoe, Cousins, & Lamming, 2016; Shaharudin, Govindan, Zailani, & Tan, 2015; Vermeulen & Ras, 2006).

With increased societal and environmental awareness, as well as the passing of Extended Producer Responsibility (EPR) legislation, governments and other stakeholders are starting to hold companies more accountable in regard to closing their material loops to ensure proper End-of-life (EOL) product disposition (Govindan, Soleimani, & Kannan, 2015; Ilgin & Gupta, 2010; King, Burgess, Ijomah, & McMahon, 2006; Zhang, Shrivastava, Whitley, & Merchant, 2004). In addition to these stakeholder pressures, companies are also facing other challenges such as uncertainties and risks in resource and commodity prices, increased complexity of products and services, as well as scarcity of resources and increased consumption rates (EMF, 2013a; Okongwu, Morimoto, & Lauras, 2013; Rashid, Asif, Krajnik, & Nicolescu, 2013). Companies can address these issues by moving away from a linear economy and towards participating in a Circular Economy (hereafter, CE) (Ghisellini, Cialani, & Ulgiati, 2016). The main goal of the CE is thus decoupling environmental impacts such as raw material extraction from economic development by focusing on the continual reuse of materials (EMF, 2015a; Ghisellini et al., 2016; McDonough & Braungart, 2000). When products are recovered, it can have significant positive impacts on society, including improvement of environmental and human health, increased job creation, and the formation of new business opportunities (EMF, 2015a; Govindan, Jha, & Garg, 2016; Shaharudin et al., 2015).

The adaptation of the CE in sustainable supply chain practices can be seen by the implementation of "closed-loop" supply chains (hereafter, CLSCs), that enable the reuse of products and materials (Genovese, Acquaye, Figueroa, & Koh, 2015; Nasir, Genovese, Acquaye, Koh, & Yamoah, 2016). CLSCs consist of a traditional forward supply chain (hereafter, FSC) where materials are taken from the reverse supply chain (hereafter, RSC) through recovery activities such as repair, reconditioning (i.e., refurbishment), or remanufacturing of materials to eventually return to the FSC (Genovese et al., 2015; Singhry, 2015; Wells & Seitz, 2005). These recovery activities can be seen as inter-linkages within the CLSC, or in other words mechanisms for closing the material loop (Nielsen &

Brunø, 2013; Özkır & Başlıgıl, 2012; Schenkel, Krikke, Caniëls, & Van der Laan, 2015). Although CLSCs may be complicated and challenging to implement, moving towards a more holistic strategy of a closed system can help to increase value creation for multiple stakeholders both internal and external to the company such as supply chain members, consumers, and non-governmental organizations (NGOs) (Genovese et al., 2015; Maloni & Brown, 2006; Schenkel, Caniëls, Krikke, & Van der Laan, 2015). This comprehensive or holistic focus leads to companies paying greater attention to how they can create value according to the three dimensions of sustainability (economic[1], environmental, social), hereafter referred to as sustainable value creation (SVC).

1.2 Scientific Problem

With increased interest in the circular economy and sustainability in supply chains, various activities have been taking place such as: new campaigns being developed (Netherlands Circular Hotspot, 2015), the creation of cross-sectoral networks (European Remanufacturing Network, 2015), as well publications about the CE (EMF, 2015a). Companies are participating in these activities in order to find ways to integrate SVC in their CLSC activities to improve their standing with stakeholders or license to operate (Salzmann, Ionescu-Somers, Steger, 2006). Within the recent scientific literature, studies have looked into the circular economy, CLSCs, and recovery activities, with emphasis on the following themes: extensive reviews of CLSC literature (Guide & Van Wassenhove, 2009; Schenkel, Caniëls et al., 2015; Souza, 2013), reverse logistics (De Brito, Dekker, & Flapper, 2005; Govindan et al., 2015), remanufacturing (Savaskan, Bhattacharya, & Van Wassenhove, 2004), CLSC design (Özkır & Başlıgıl, 2012), and the CE (Genovese et al., 2015). Furthermore, when focusing on CLSCs, research has concentrated mostly on the forward supply chains (FSCs) (Cox, 1999) and an integrated view of the FSC and RSC is not evident or entirely absent (Schuh, Novoszel, & Maas, 2011). Despite growing interest in CLSC research, studies are lacking an emphasis on value creation in the integrated CLSC (i.e., FSC and RSC together) (Schenkel, Caniëls et al., 2015).

Studies like those from Schenkel and Caniels et al. (2015) focus on different types of value manifestations and separate them into individual categories; thus, studies contributing towards the investigation of sustainable value where the three dimensions are viewed holistically within CLSCs is not evident. Furthermore, studies centering around value mostly look into the aspects of capturing value through product returns (Guide & Van Wassenhove, 2009) or recovery of value through products activities such as remanufacturing (San & Pujawan, 2012). The overarching theme of sustainable value creation is lacking in scientific literature.

Most importantly, a majority of studies regarding CLSCs tend to have a theoretical approach and a real-world, practical perspective is needed (Difrancesco & Huchzermeier, 2016). Accordingly, it is important to find out and explore how companies can support further sustainable value creation in CLSCs. Furthermore, it is critical to account for not only different types of companies that participate in CLSCs but also address specific sectors.

[1] Economic in the broader sense of prosperity; more than just narrow accounting focus. (Vermeulen, & Witjes, 2015; Pagell, & Wu, 2009)

Addressing different sectors accounts for the following aspects: Product types within sectors affect the context of the design and characteristics of a company's CLSC (Wells & Seitz, 2005), and the return rates from recovery activities (Rogers & Tibben-Lembke, 2001) as well as the regulatory and social pressures can vary greatly (Stindt & Sahamie, 2014). Although the literature has contributed to the field of research in CLSCs, there is an overall lack of understanding of what contributes to or enables SVC in multiple sectors in CLSCs.

1.3 Research Objectives and Research Question

To address the gaps in research, an exploratory study is appropriate in order to look further into the different variables and contexts surrounding the role that companies play in sustainable value creation within closed-loop supply chains. Therefore, the following research question has been formulated:

How are companies addressing sustainable value creation within closed-loop supply chains?

The term "*addressing*" in this study is defined as the intention of bringing under discussion or dealing with something, in other words, how companies are doing something practical, with an end goal of creating an environment more suitable for sustainable value creation. Since this research is broad and exploratory in nature, a more specific research aim is to further understand how specific *strategies, methods, and tools*, hereby defined as "*factors,*" work to enable sustainable value creation within closed-loop supply chains. Therefore, the following sub-questions have been formulated to aid in answering the main research question:

Sub-question 1: Which specific factors are companies utilizing in closed-loop supply chains that enable sustainable value creation?

Sub-question 2: Which combinations or interactions of factors exist that enable sustainable value creation in closed-loop supply chains?

Sub-question 3: Which factors are most important for enabling value sustainable creation within closed-loop supply chains according to specific companies as well as between different sectors?

The final sub-question addresses the different recovery activities within CLSCs (e.g., repair, reconditioning/refurbishment, remanufacturing, and recycling).

Sub-question 4: Which types of companies and sectors are participating in each of the different recovery activities?

To answer the research question and sub-questions, a new theoretical model based on the literature regarding factors that enable sustainable value creation was developed. To operationalize the theoretical model, a multiple case study analysis was employed for

various companies between multiple sectors that participate in closed-loop supply chains (sub-chapter 3.2.1).

1.4 Scientific and Societal Relevance

This study contributes to scientific relevance by taking an exploratory approach to the research question and investigating real world case studies with multiple types of companies spanning multiple sectors. The information that will be derived from this study will enable further research in the field and will lead to the development and further testing of the theory. This study will also help companies to understand more about the current situation of SVC in their sectors, and which specific factors may contribute to an environment more suitable for value creation. The findings from the research will provide leaders and strategic functions in these companies further insight and recommendations to help them begin to evaluate their own systems and to come up with strategies to create sustainable value in their CLSCs.

In terms of societal relevance, this study contributes in the following ways. First of all, enabling companies to further their development in the CE or further integrate recovery activities in their business strategy can contribute to the increase in recovery of materials. Giving multiple life-cycles to products or materials can result in the creation of new business models with development of new infrastructures and increased job creation (Sarkis, Helms, & Hervani, 2010). Furthermore, increased value creation in CLSCs can contribute in healthier environments, innovative partnerships, and can lead to the formation of entirely new business models based on the recovery of materials (Bocken, de Pauw, Bakker, & Van der Grinten, 2016; EMF, 2013a; Florin et al., 2015; Khor & Udin, 2013). The results of this research could help to stimulate conversations on the national and international level regarding policies and legislation that may result in concrete steps or initiatives to help support companies in their goals of creating sustainable value.

1.5 Research Outline

This thesis document is structured as follows: In Chapter 2, the theoretical background is presented, covering more in-depth information on the circular economy (CE), closed-loop supply chains (CLSCs), recovery activities in CLSCs, sustainable value creation (SVC), factors that support or enable SVC in CLSCs, as well as interactions between factors. The information in these sub-chapters forms the foundation for a theoretical model that has been developed. In Chapter 3, the research methods are explained including the overall research design framework, which consists of the introduction of the research scope, description of data collection and data analysis, as well as limitations of the methods. In Chapter 4, the findings resulting from the data collection are summarized in the form of case studies. Chapter 5 details the questionnaire results in graphical terms in order to better organize and illustrate the findings from the research activities. Chapter 6 includes the discussion of the results and findings, the limitations of the study, and the development of recommendations for further research. In Chapter 7 final conclusions are drawn for the research and recommendations are given for the case-study companies, other organizations, as well as policy makers and the government.

2 Theory

2.1 Circular Economy Background

More recently, increased attention has been given to the concept of the circular economy (CE) as being able to address economic growth, while at the same time ensuring environmental health and well-being are accounted for (Heshmati, 2016; Lieder & Rashid, 2016; Murray, Skene, & Haynes, 2015). The CE has been considered a strategy for promoting efficient resource use that leads to reductions in negative impacts on the environment and society (Florin et al., 2015; Ghisellini et al., 2014). The concept of the CE has a goal of taking a linear economy based on take-make-dispose and transforming it into a take-make-recreate economy that enables a circular flow of products and resources (EMF, 2014; Florin et al., 2015).

Specific drivers are motivating companies to address the CE such as:

1. ***Government Policies and Initiatives***: Government legislation such as extended producer responsibility (EPR) legislation has been passed to address specific products or sectors such as the Waste of Electronic and Electrical Equipment (WEEE) or End-of-Life Vehicle (ELV) directives (EPCEU, 2000; EPCEU, 2003). Additionally, new government initiatives such as the EU's Action Plan for the Circular Economy and UK Government's Resource Security Action Plan have put the CE on the forefront of governments' agendas (DEFRA, 2012).

2. ***Environmental Impacts and Other Business Risks***: With growing populations due to urbanization and globalization, demand for natural resources will rise and will result in higher raw material prices (EMF 2013a; Hobson, 2015). Additionally, with more products nearing EOL, increased environmental risks include more waste being disposed in landfills or incinerators (Dowlatshahi, 2000).

3. ***Economic and Business Opportunities***: New business and job opportunities exist within the CE specifically for recovering returned products such as in regard to remanufacturing or recycling processes (EMF, 2015a; Quariguasi Frota Neto, Walther, Bloemhof, Van Nunen, & Spengler, 2010). Furthermore, jobs will be created in multiple sectors, and will be developed through innovative and entrepreneurial activities (EMF, 2015a).

4. ***Technological Challenges***: Technological obsolescence is driving the increase in levels of e-waste and making the life-cycle of products increasingly shorter with each update (Bhattacharjee & Cruz, 2015; Geyer & Blass, 2010). While this creates waste, it can also lead to business opportunities for recovery and recycling (Bhattacharjee & Cruz, 2015; EMF, 2014).

5. ***Changes in Customer Demands***: Consumer trends in purchasing and behavior are leading to new opportunities in the CE where customers are more accepting of the concept of use or access instead of ownership (EMF, 2013a). Furthermore, customers

are demanding more responsible and sustainable products and services from existing companies and are driving the creation of new companies to fit those needs (De Giovanni, 2014; Kara, Ibbotson, & Kayis, 2014).

To address these challenges, companies need to adopt new radical social, economic, and technological systems that transform the way they do business (Florin et al., 2015). According to Osterwalder and Pigneur (2010, p.14), business models describe the "rationale of how an organization creates, delivers, and captures value." According to Florin et al. (2015, p. 53), circular business models are considered to be a subset of sustainable business models; however, a key difference is that circular business models "must be oriented towards consumption, or production and consumption, to promote both efficiency and sufficiency." Circular business models focus on the customer as a user rather than a consumer where products can be leased, rented, or shared (Antikainen, Lammi, Paloheimo, Rüppel, & Valkokari, 2015; EMF, 2013a). Product-Service Systems (PSS) are a good example of applying the CE within business models, where it allows companies, especially those in industrial or manufacturing settings, to innovate and improve product and material recovery (Rashid et al., 2013). Some companies are focusing on leasing programs with maintenance and repair schemes (Tukker, 2013), while others offer full product remanufacturing programs that help to ensure product ownership and support the goal of continued life-cycles for the product (Hatcher, Ijomah, & Windmill, 2014).

Circular business models help to drive value creation within the CE in the following four ways (EMF, 2015a):

Figure 1. The Power of the Inner Circle

The Power of the Inner Circle: The smaller or tighter a circle, the less amount of material is used and fewer times the product goes through major changes. This loop is characterized by lower levels of material use, energy, or labor and thus results in reduction in costs.

Figure 2. The Power of Circling Longer

The Power of Circling Longer: The increased number of times a product or material can be used, the longer the lifetime and the longer the value is retained. This can be carried out through increased time in each cycle or by the activities of reuse, remanufacturing, or recycling.

The Power of Cascaded Use: When one material or product is used for one type of sector or industry, and during its second or third life crosses boundaries to a different product or sector area, it is then benefitting these areas by avoiding the need for new raw material inflows.

Figure 3. The Power of Cascaded Use

The Power of Pure Circles: When products are non-toxic, or uncontaminated, it increases the efficiency of recovery and separation processes, while at the same time preserves the material quality and productivity, thus providing a longer life-cycle.

Figure 4. The Power of Pure Circles

(Figures 1-4 as well as the summarized information above are sourced from EMF, 2015a).

With the development of more circular business models that enable the continual reuse of products, it is important for companies to give attention to recovering value in the supply chain that come from post-consumer products (EMF, 2013b). Furthermore, with the addition of these new innovative circular business models, companies will need to address all aspects of their supply chain especially those that concern reverse logistics such as, collection, sorting, inventory management, transportation optimization, location of collection facilities, and logistics network design (Agrawal, Singh, & Murtaza, 2015; Schuh et al., 2011; Tahirov, Hasanov, & Jaber, 2016). Therefore, supply chains will need to be transformed from the front to the end by forming a cyclical closed-loop system to meet the objectives of the CE (Murray et al., 2015).

2.2 Closed-Loop Supply Chains (CLSCs)

Companies are beginning to actively modify their strategies for recovery by changing from a more traditional supply chain structure to that of a closed-loop supply chain (CLSC) (Bocken et al., 2016; Nielsen & Brunø, 2013; Toffel, 2004). These changes come with new challenges for companies, such as learning to collaborate with new or unexpected partners, as well as shifting their strategies from operational based issues to value-creating systems (Florin et al., 2015; Guide, Harrison, & Van Wassenhove, 2003). CLSC management is defined by Govindan et al. (2015, pp. 603-604), as "the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time." CLSCs are thus concerned about sustainability within supply chain operations (Kleindorfer, Singhal, & Van Wassenhove, 2005) where the ends of the loop must be closed to ensure not only economic performance but also to address environmental and social elements (Genovese et al., 2015; Walker, Seuring, Sarkis, & Klassen, 2014).

2.2.1 Recovery Activities in CLSCs

Within the CLSC the two main components include the forward supply chain (FSC), which encompasses typical functions and steps within the chain (e.g., processing, manufacturing, distribution, and sales), including those at the source of flow of materials and termination of the flow with the end user (Özkır & Başlıgıl, 2012). The reverse supply chain (RSC) is the opposite direction of the FSC and is composed of recovery activities (i.e., interlinkages) that bring the flow of materials back to the original source (e.g., manufacturer) (Clifford Defee, Esper, & Mollenkopf, 2009; Özkır & Başlıgıl, 2012; Prahinski & Kocabasoglu, 2006; Schenkel, Caniëls et al., 2015). While in the past, the concept of taking back products was seen as bothersome, more recently companies are recognizing that EOL products are a source of value and therefore they are more proactively addressing product recovery (Schuh et al., 2011). Within the RSC there are specific recovery activities that are mentioned in literature and include repair, reconditioning (i.e., refurbishing), remanufacturing, and recycling (Dekker, Fleischmann, Inderfurth, & Van Wassenhove, 2004; King et al., 2006; Singhry, 2015; Thierry, Salomon, Van Nunen, & Van Wassenhove, 1995). These four recovery activities (i.e., recovery loops) have been visualized in Figure 5 and begin after a product is no longer fit for its original use.

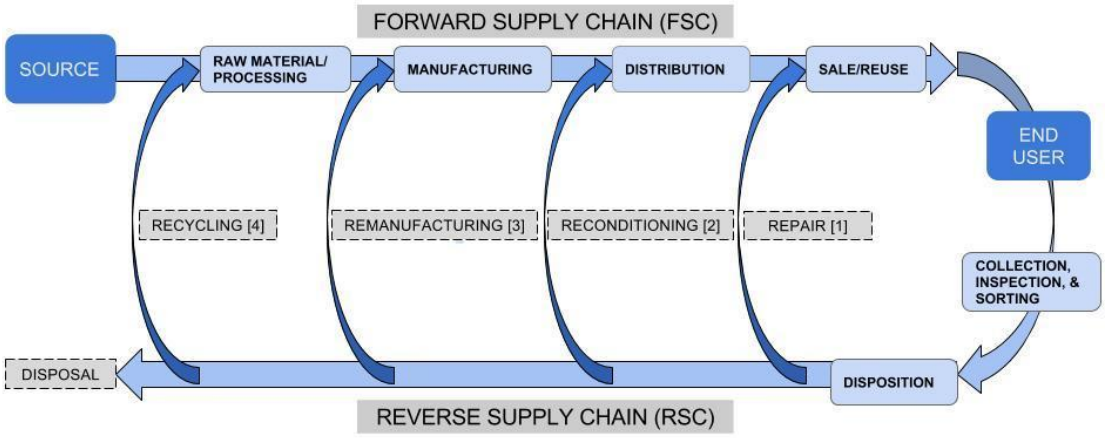


Figure 5. Closed-loop Supply Chain Visualization. Source: Author's own adapted from Agrawal et al. (2015, p. 78); Khor & Udin (2012, p. 3); King et al. (2006, p. 260); and Quariguasi Frota Neto et al. (2010, p. 4465).

Once collection, inspection and sorting are completed, materials and products are handled using different disposition options such as repair, reconditioning, remanufacturing, recycling, or disposal. Disposal is considered to be part of their RSC, but does not fit within the boundaries of the CLSC system. When products are returned to the original product manufacturer it is considered a fully closed loop (Genovese et al., 2015). Wells and Seitz (2005) explain that some loops are referred to as being partially closed loops when the product leaves the domain of the original manufacturer and becomes part of a new loop such as through a third party recycler, or a third party company that recovers the materials for an entirely new purpose. Furthermore, the authors state that reconditioned products that are sold outside the scope of the original manufacturer, or external recycling can be

considered as a modification of a closed loop since it is a system which functions within independent markets or logistics systems.

Repair

The first recovery loop shown in Figure 5 is repair, which aims to correct minor faults and get products back into working condition so that they can be sold again or reused (King et al., 2006; Thierry et al., 1995). Furthermore, King et al. (2006) state that repaired products are usually lower in quality than those reconditioned or remanufactured; however, they have the highest environmental benefit as the repair activities use the least amount of energy to make them acceptable for return to the FSC.

Reconditioning

The second recovery loop, reconditioning (i.e. refurbishing), requires major components to be rebuilt through an assembly process, often to create a lesser version of the original product (King et al., 2006; Thierry et al., 1995). Often, after disassembly, certain "modules" are updated or replaced, and in some cases are upgraded due to advancements in technology (Thierry et al., 1995). While reconditioning requires more energy than repairing (but less than remanufacturing or recycling), the reconditioned products cannot be considered new and thus have the same resulting market value as repaired products (King et al., 2006). Furthermore, the authors state that while this recovery loop along with repair is least energy-intensive, there are barriers that prevent utilization of this recovery loop including consumer behavior in regards to returns and manufacturers' expectations of new sales.

Remanufacturing

The third recovery loop, remanufacturing, occurs when products that are discarded or non-functional are brought back to the original specifications of the manufacturer and given warranties equal to those of new products (Ijomah, 2002; King et al., 2006; Lund & Hauser, 2010). When products are remanufactured in an economically viable way, remanufacturing can be one of the best choices for reduction of material usage and overall impact to the environment (Kaebernick et al., 2006; San & Pujawan, 2012). According to Rashid et al. (2013), remanufacturing can lead to a savings in resources as well as avoiding environmental damage. As an example the authors have determined in their study that a remanufactured product only requires 50-80% of energy expenditure than that of a new product, which in turn can then result in similar levels of reduced waste as well as avoided C02 emissions. However, there are significant barriers involved regarding this recovery loop such as disassembly costs, logistics costs, as well as overall lack of demand for these products (King et al., 2006). One strategy that could increase the success of remanufacturing is for companies to develop product-service systems (PSS), where companies could create agreements with their customers to lease products rather than own them, enabling a recovery loop that promotes the return of products for remanufacturing (King et al., 2006).

Recycling

The last and most commonly utilized recovery loop is recycling. Recycling, according to NRC (1999) as cited in King et al. (2006), includes collection, sorting, and processing of discarded materials for use in new products. Furthermore, King et al. (2006) explain that the reason this loop is often most applied is when product guarantees are minimally applied or absent altogether. Because of this, many companies do not keep track of or address what happens to products after a warranty has expired. Another driving force for companies choosing recycling is the perception that recycling is still considered an environmental acceptable option in today's practices (Fairlie, 1992, as cited in King et al., 2006). While this is the most common recovery loop, it is actually the most energy intensive because the product is fully transformed, losing its previous functionality and identity (Thierry et al., 1995). Therefore, literature shows companies should move away from this second class recovery option, and give more priority to repairing or reconditioning which allow value recovery through partial product reuse (Inderfurth, 2005, and Simpson, 2010, as cited in Gobbi, 2011).

2.3 Sustainable Value Creation

Closed-loop supply chains (CLSCs) and recovery activities can be seen as main supporting elements contributing to sustainable operations and creation of value (Jawahir & Bradley, 2016; Stindt & Sahamie, 2014). To create value more sustainably, the types of value created in CLSCs should take into account a holistic view of sustainability that addresses social, economic[2], and environmental aspects (D'heur, 2015; Elkington, 1997). Sustainable value is created when a company is committed to structuring all aspects of its core business (i.e., products and supply chains) in ways that deliver *economic*, *ecological*, and *societal* value-add at the *same time* (D'heur, 2015). Sustainability needs to be fully integrated within the strategies of a company, and should move beyond the main organizational objectives that involve generating profits (Sharma, 2003 as cited in Ciasullo & Troisi, 2013). The process of sustainable value creation (SVC) should thus involve multi-stakeholder collaboration to ensure partners such as those in the supply chain and those that provide functional resources to the company are involved (Ciasullo & Troisi, 2013; D'heur, 2015; Lee, 2010). Sustainable value is created in multiple ways in CLSCs. For example, the remanufacturing of products creates value for the *company* as well as for the *environment* as it reduces the amounts of raw materials required for new products and furthermore benefits *society* by creating new jobs within remanufacturing processes (King et al., 2006).

2.4 Factors that Enable SVC

In a recent study, Schenkel, Caniëls et al. (2015) reviewed literature and compiled an extensive list of value-adding concepts from the literature that were found to leverage the process of value creation in CLSCs. This study looks at evaluating and categorizing the concepts that exist in the literature, but does not measure or give an indication of the

[2] Social, relating to people, environmental, relating to the planet, and economic, relating to prosperity that goes beyond the idea of profit as the main focus (Vermeulen & Witjes, 2015).

relative importance or level of impact of each concept. The authors also found manifestations of value in CLSCs and categorized them as environmental, social, technological, and customer value. This thesis takes the findings of this study and further explores these value manifestations by addressing them through the holistic lens of sustainable value creation. Keeping in mind the exploratory nature of this study, it is important to investigate if the factors found in literature that result in various singular value manifestations could also result in sustainable value. It can be argued that any of these value-adding concepts or *factors* as referred to in this research can be connected to the possible creation of sustainable value. Further reasoning would then conclude that any improvement or optimization of either the CLSC as a whole or development recovery activities can lead to the eventual creation of sustainable value. Therefore, it is important to refer to these specific factors as those that *enable* sustainable value creation. According to Merriam-Webster dictionary, the term enable implies "to provide with the means or opportunity, or to make possible" (Merriam-Webster, n.d.). Therefore in this study, various value-adding concepts that have been found in literature will be gathered and organized as specific factors to determine if they *enable* sustainable value creation in CLSCs.

The paper by Schenkel, Caniëls et al. (2015), along with additional sustainable supply chain, CLSC, CE, and reverse logistics literature, have been reviewed to determine specific factors that could enable SVC in CLSCs. Given the extensive amount of information, the factors that were found were combined into more concise and overarching categories of Social/Relational, Technological, Operational, and Organizational, making it easier to approach and analyze the topics for the research. Appendix 1, Tables 7-10, include all factor descriptions, detailed examples, and a full list of literature sources. The following sub-chapters go into further detail about the factor categories and specific factors that will be analyzed.

2.4.1 Social/Relational Factors

The first category of Social/Relational factors applies to social aspects (involving or regarding people) as well as relational aspects (how people interact and are connected). These factors include main interactions between individuals or companies that are *outside* of the boundaries of the organization such as cooperation, coordination, and collaboration. Spekman, Kamauff Jr., and Myhr (1998) describe the three levels of interaction from a supply chain perspective as: [1] cooperation, where engagement and interaction begins between suppliers, [2] coordination, where exchanges of information are carried out to allow for closer linkages and finally, [3] collaboration, where partnerships are developed through trust, commitment, and joint planning in which supply chains become more integrated. Collaboration is critical as it enables part recovery back into the FSC (Schenkel, Caniëls et al., 2015). In line with the resource-based view (RBV) of a firm, boundary-spanning relationships such as collaborations play a key role in the development of inimitable resources and capabilities for enabling success and for creating win-win situations (Blome, Hollos, & Paulraj, 2014; Pagell, Wu, & Wasserman, 2010; Teece, Pisano, & Shuen, 1997; Toffel, 2004). Within CLSCs collaboration can occur between primary stakeholders such as suppliers, customers, and the government as well as inter-firm relationships and with secondary stakeholders such as NGOs, and the local community

(Corbett & Klassen, 2006; Freeman, 1984, as cited in Schenkel, and Krikke et al., 2015; Matos & Silvestre, 2013). Collaboration is important with suppliers to develop relationships to work together on waste reduction in regard to their products and processes and to foster innovation (Theyel, 2006; Vachon & Klassen, 2008). Customer collaboration is also important as customers are one of the main driving forces in incremental product design and have a significant effect on the volumes and quality of product returns (Rashid et al., 2013). Furthermore, Non-Governmental Organizations (NGOs) such as environmental NGOs are important for collaboration as they can link businesses and other environmental stakeholders to develop new entrepreneurial innovations, and can also offer scientific and legal advice to companies (Stafford, Polonsky, & Hartman, 2000). Collaboration with the government is critical as they are actively participating in initiatives to further the development of the circular economy and proposing legislation to help stimulate activities in specific sectors for new business and job creation (EC, 2015). In summary, the main goals of CLSC collaboration are to develop resources, exchange information, adopt new innovations, and to achieve sustainable goals (Vachon & Klassen, 2006 as cited in Elbounjimi, Abdulnour, & Ait-Kadil, 2014; Gold, Seuring, & Beske, 2010; Zhu, Sarkis, & Lai, 2007).

Table 1 below comprises the full list of Social/Relational factors found from the literature. Appendix 1 Table 7 includes examples and corresponding sources of literature for each factor.

Factor Topic
● SR1-Collaboration with Suppliers
● SR2-Collaboration with Customers
● SR3-Collaboration with the Community
● SR4-Management Collaboration Outside of Company
● SR5-Inter-firm Collaboration
● SR6-Collaboration with Government
● SR7-Collaboration with NGOs
● SR8-Collaboration with Other Stakeholders

Table 1. Social/Relational (SR) Factors

2.4.2 Technological Factors

The second category of factors is concerned with technological aspects such as those pertaining to technology, information, and related tools and concepts. Advances in the Information Technology (IT) field are growing larger every day where more creative solutions, such as those implemented in both flows in the CLSC could lead to additional sustainable value (Huang & Yang, 2014; Schenkel, Caniëls et al., 2015). Technologies within supply chains enable the dissemination of information and ideas that can lead to increased knowledge sharing (Gold et al., 2010). The development of IT systems and infrastructure within supply chain processes helps companies to move away from simple data exchanges, such as for purchasing, to activities that lead to more effective collaboration as well as improvements in responsiveness between partners (Beske & Seuring, 2014; Daugherty, Richey, Genchev, & Chen, 2005; Morgan, Richney Jr., & Autry, 2016). Coupling fully developed traditional internal IT capabilities with external IT technologies such as tracking

and tracing allows for a better integration of external stakeholders such as supply chain partners into the CLSC system (Koppius, Özdemir Akyıldırım, & Laan, 2015). Further development of technologies such as radio-frequency identification (RFID) tags, global positioning system (GPS), sensors, and other devices helps to support supply chain transparency (IBM, 2010). Jayaraman, Ross, and Agarwal (2008) further support the use of tracking tools such as radio-frequency identification device (RFID) technologies, which help to provide information about the location of a product as well as inventory levels in the supply chain. Other systems such as enterprise resource planning (ERP) help to manage the reverse flow of products, but have room for improvement to further optimize information about the location and condition of returned products (Jayaraman et al., 2008). Therefore, the continued attention to and investigation into new technology innovations is critical for companies who are working to optimize their CLSC systems.

Table 2 below comprises the full list of Technological factors found from the literature. Appendix 1 Table 8 includes examples, and corresponding sources of literature for each factor.

Factor Topic
● TC1-Infrastructure of Information Systems
● TC2-Business Process Planning Software
● TC3-Tracking and Locator Systems
● TC4-Wireless Communication/Sensors
● TC5-IT & Information Sharing

Table 2. Technological (TC) Factors

2.4.3 Operational Factors

Operational factors include those that relate to company operations and how a business functions. Many structures, designs, and decisions made for operational purposes can affect CLSC processes significantly, such as the packaging design, logistics routes and network design, or procurement decisions (Carter & Liane Easton, 2011; Dowlatshahi, 2000; Zhu, Sarkis, & Lai, 2008). For example, the purchasing function is also key for value creation by supporting green purchasing which can address concerns such as waste reduction, as well as help to develop strategies of sourcing more sustainable materials (Rao & Holt, 2005). Product design is mentioned as one of the most important factors for enabling the return and recovery of products such as design for disassembly or modularity (Go et al., 2015; Khor & Udin, 2013; Quariguasi et al., 2010). Additionally, certifications such as ISO 14001 can be used as an auditing tool for suppliers to ensure they are addressing sustainability in regard to their products (Rao & Holt, 2005). Along with product design, the assessment of life cycle impacts of products through the implementation of life-cycle analysis (LCA) can give insight into a product's environmental impacts in regards to manufacture, resource consumption, or EOL decisions such as recycling (Gungor & Gupta, 1999; Gurler, 2011; Keoleian & Menerey, 1994). After-sales activities such as leasing and product-service systems (PSS) give extended life to products and enable companies to monitor their products for information that can be used to understand how the product is functioning (Tukker, 2015). Other supply chain specific factors such as labeling, resource management, inventory management, as well as shipping and transportation considerations were also

found to be important factors according to the literature (Dowlatshahi, 2000; Pokharel & Mutha, 2009). Overall, the coordination between cross-functional departments within the forward and reverse supply chain such as between purchasing, manufacturing, product design, logistics, and marketing is essential to enabling value creation in CLSCs.

Table 3 below comprises the full list of Operational factors found from the literature. Appendix 1 Table 9 includes a full list of examples, and corresponding sources of literature for each factor.

Factor Topic
● OP1-After-sales & Recovery Services
● OP2-Certifications/Standards, Policies/Procedures
● OP3-Labeling
● OP4-Product Design Considerations
● OP5-Packaging Considerations
● OP6-Product Life-Cycle Management
● OP7-Inventory/Stock Considerations
● OP8-Sales/ Marketing Structure & Activities
● OP9-Resource Management
● OP10-Purchasing Structure & Activities
● OP11-Shipping and Logistics
● OP12-Supply Chain Considerations

Table 3. Operational (OP) Factors

2.4.4 Organizational Factors

According to Lozano (2012), when companies are moving towards becoming more sustainability oriented, they tend to focus more on *hard* techno-centric solutions and forget to address *soft* issues such as the company values, culture, or policies. However, in order for a company to be successful in managing sustainability, they must first address soft issues within the organization, and then work on implementing hard systems such as the structure or specific programs (Epstein, Buhovac, Yuthas, 2010). The same philosophy should be applied to companies who are motivated to create sustainable value in their closed-loop supply chains. The first step for companies that are addressing sustainability within their supply chains is to orient themselves towards sustainability or to adopt a sustainable mindset (Beske & Seuring, 2014; Pagell & Wu, 2009). A sustainable mindset enables the alignment of financial and environmental goals in order to integrate sustainability within all areas of the supply chain (Pagell & Wu, 2009). Furthermore, sustainability must be integrated within the strategy of the company, starting with the top-management. Specifically, when addressing CLSC systems in a company, the support and commitment of leaders such as top management is key to help them deal with new ways of thinking and to overcome the challenges that come with implementing radical changes (Rashid et al., 2013). Burgess, Singh, and Koroglu (2006) refer to this proactive engagement of top management as *leadership*. According to San and Pujawan (2012), leadership is one of the least talked about topics within the CLSC literature. Leadership is important in CLSCs, as it can help to effectively navigate complex supply chains to help multiple parties coordinate within the supply chain (Lambert et al., 1998b, as cited in Clifford Defee et al., 2009). Finally, informal or non-traditional leaders can help to fill positions left open by formal leaders and can

contribute to change within many levels of an organization (Hamner, Cohen Hall, Ciulla Timmons, Boeltzig, & Fesko, 2008; Neubert, 1999). These informal leaders, such as sustainability champions, should be included when trying to gain commitment to new ideas or projects (Gattiker & Carter, 2010).

In addition to the strategic alignment for sustainability, cross-functional integration must be in place to enable innovation and information sharing across the supply chain (Huang & Yang, 2014; Spekman et al., 1998). In regard to CLSCs, when all members of an organization are involved and collaborate together, or in other words are functionally integrated, they are more effective in managing returns (Mollenkopf et al 2007b in Mollenkopf, Frankel & Russo, 2011). When an organization is functionally and strategically aligned, it builds a culture of sustainability, which can drive further sustainable behavior as well as attract and engage employees (Holt & Ghobadian, 2009; Pagell & Wu, 2009). Focusing on employee relations, such as ensuring work-place safety or work-life balance is important to ensure equity, development, and well-being (Closs, Speier, & Meacham, 2011; Kelliher & Anderson, 2008; Gollan, 2000 as cited in Wilkinson, Hill, & Gollan, 2001). Moreover, according to Colbert and Kurucz (2007) as cited in Closs et al. (2011), employee training and development programs can give employees the necessary skills and capabilities to address sustainability within their own objectives. The authors also state that combining soft and technical skills are crucial to preparing employees for work environments such as in a global setting.

Table 4 below comprises the full list of Organizational factors found from the literature. Appendix 1 Table 10 includes a full list of factors, examples, and corresponding sources of literature.

Factor Topic
● OR1-Organizational Alignment
● OR2-Corporate Strategy
● OR3-Collaboration with Employees
● OR4-Leadership Internal
● OR5-Company Culture/Philosophy

Table 4. Organizational (OR) Factors

2.4.5 Interaction of Factors

According to Schenkel, Caniëls et al. (2015), there is a distinct gap in the literature where the complementary interactions that lead to value creation have not been fully researched. Therefore, it is important to address this gap, and to understand which factors are often found in combination with other factors and can interact to create an environment more suitable for value creation. For example, if research shows that collaboration with competitors to improve IT systems leads to new and innovative processes to gather recovery data, it is crucial that these types of interactions are recorded so that companies can address them within their CLSC strategies.

One study by Rashid et al. (2013, p. 170) focuses on the concept of Resource Conservative Manufacturing (ResCoM), and takes a look at closed-loop product systems and management of products and materials throughout the entire lifecycle in order to "transfer the current perspective of waste management to value management." Furthermore, the

authors also state that the goal of this new concept is to take into account the cross-functional integration within organizations such as within the manufacturing, supply chain, product design, and marketing functions.

Part of the overall ResCoM framework includes a model that focuses on the importance and support of collaboration functions; Marketing and Customer Behavior, Product Design and Development, Manufacturing and Remanufacturing Technologies, and Supply Chain Design and Management (Rashid et al., 2013). See Figure 6 below for the authors' model. The authors state that this model places product design at the center of the interactions because it is said to have a strong link to and impact on the surrounding categories. In addition, there are three circles that connect each of the different functions to signify the dependence they have on each-other, their interactions, and the feedback mechanisms that exist.

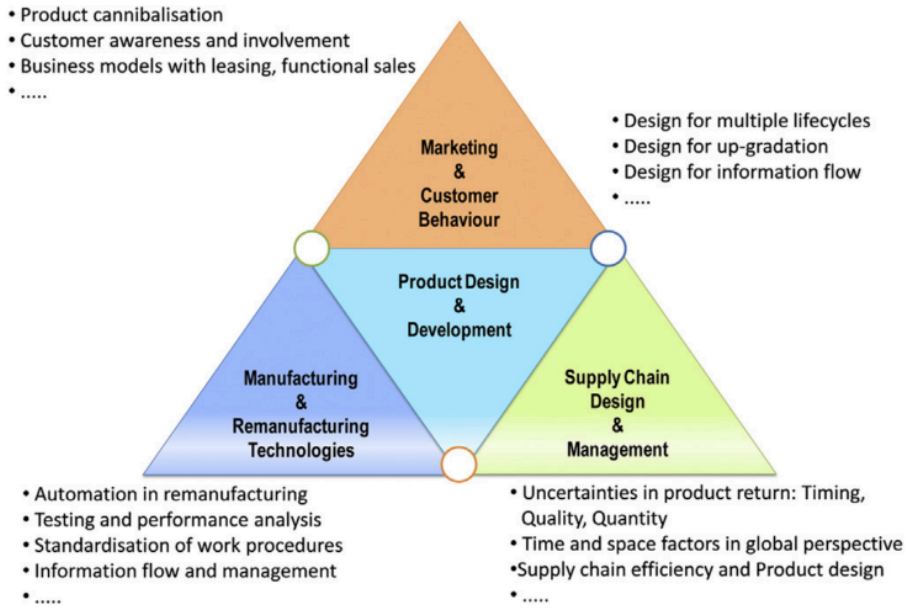


Figure 6. Cross-functional Integration in the ResCoM Framework. Source: Rashid et al. 2015, page 175.

When comparing the development of this thesis research to the main components within the ResCoM model, most fit into the Operational factor category, as described in sub-chapter 2.4.3 above. Some of the aspects of the study address the importance of top management, original equipment manufacturers (OEMs) or the involvement of customers, and emphasize that the participation of secondary stakeholders such as the public and legislative/regulatory bodies is critical (Rashid et al., 2013). Overall the authors give some important examples of factor interactions similar to those mentioned at the beginning of this chapter, for example, how supply chains must be interlinked with design of products such as designing for multiple life cycles. Therefore, this framework and the critical attention it gives to the interactions between these functions or "factors" are important to take into account for this study. The structural aspects of the framework along with the factors found in literature will form the basis of the development of a theoretical model.

2.5 Theoretical Model

In Figure 7 below, the Enabling Environment for Sustainable Value Creation in Closed-Loop Supply Chains model is visualized. This model takes into account the previous chapters and compiles them into a newly integrated configuration. Due to the exploratory nature of this research, an overall "environment" must be created that accounts for the existence of different types of factors as well as their theoretical interactions as a way to determine the current state of SVC in CLSCs. The model is a useful tool to give an overview all factors and factor categories. It can also be utilized in different ways such as for a single company or for an entire sector to help determine which environment is created in specific situations or contexts. In the figure, each factor category that enables SVC makes up the building blocks of the environment. This includes the colored sections, representing the Social/Relational, Technological, Operational, and Organizational factor categories. Furthermore, the arrows between each category allows for the investigation into the possible interactions that exist between the categories. Lastly, within each category, there are interactions that exist between the same types of factors including among others interactions between "SR" and "SR" or "TC" and "TC" factors. The question marks indicate the areas that will be analyzed and placed in relationship based on the thesis research. Appendix 1 gives details on the names and descriptions of each of the factors listed in this model.

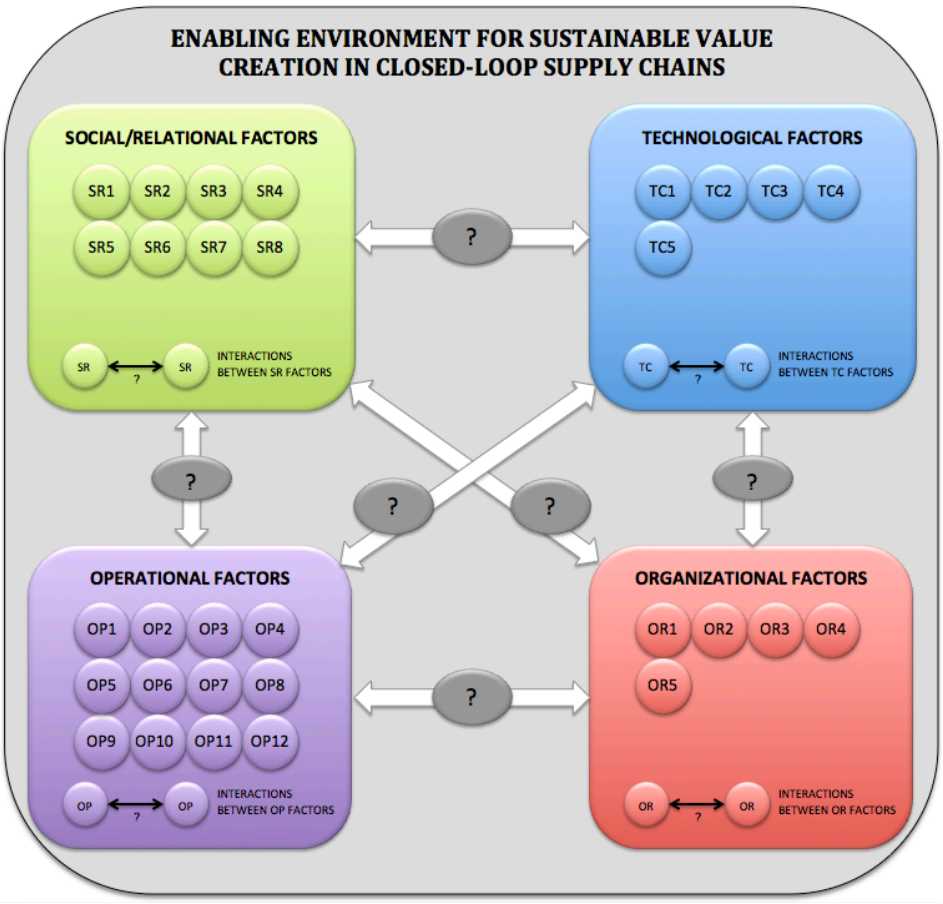


Figure 7. Enabling Environment for Sustainable Value Creation in Closed-Loop Supply Chains. Source: Author's own.

3 Methods

3.1 Research Design

This study is important to help fill the gaps in research and to delve further into a real world application that extends past the boundaries of theoretical research. To answer the research questions, a research strategy or design is needed. According to Saunders, Lewis, and Thornhill (2009, p. 141), a research strategy is dependent on "your research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources you have available, as well as your own philosophical underpinnings." Since this area concerning CLSCs and sustainable value creation has not yet been thoroughly studied, an exploratory study is valuable for finding out "what is happening; to seek new insights; to ask questions and to assess phenomena in a new light" (Robson, 2002, p. 59, as cited in Saunders et al., 2009). Figure 8 below gives an overview of the research design process flow.

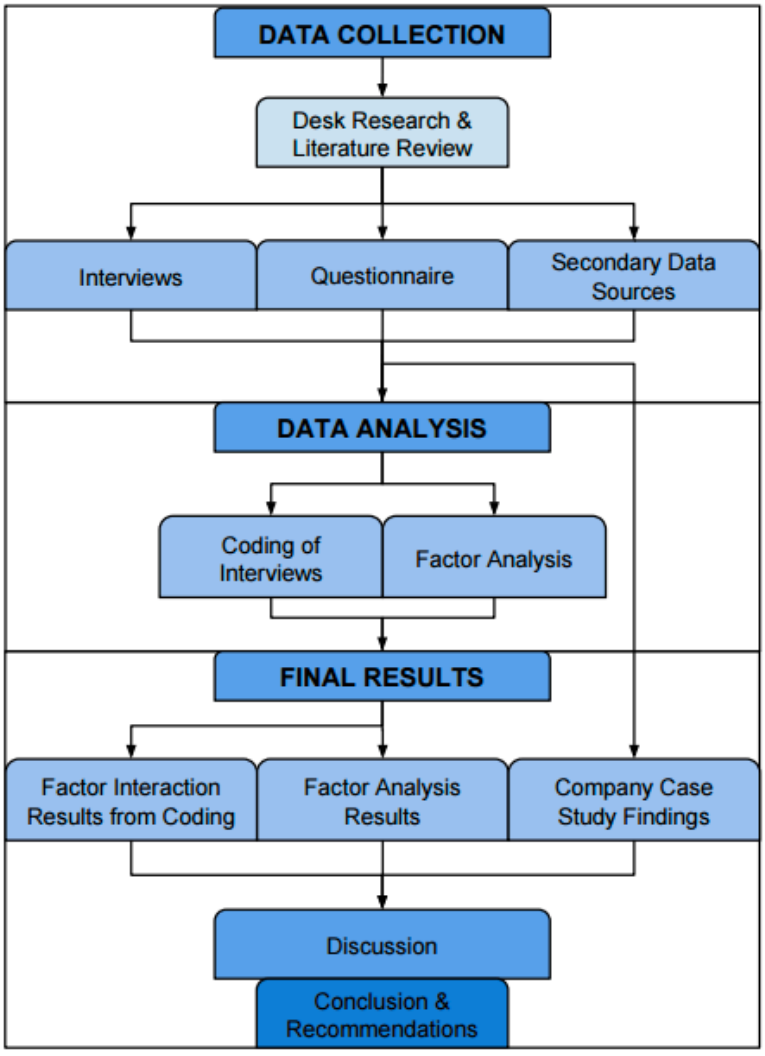


Figure 8. Research Design

Therefore, this research was conducted as an exploratory study focusing on mixed-method research activities that combines both quantitative and qualitative methods and data, to enable a more inclusive form of research, rather than restrictive or limiting (Johnson & Onwuegbuzie, 2004). The main methods employed in this study included a multiple-case study method and the subsequent utilization of data collection techniques including semi-structured interviews and survey methods (i.e., questionnaires) (Saunders et al., 2009; Yin, 2013). By utilizing these different data collection techniques, both qualitative and quantitative data have been collected. The qualitative data stemming from the interviews and transcribing process answer the "what factors and combinations of factors" part of the research question. The quantitative data resulting from the questionnaire will also answer which factors are most important for companies and sector. Bryman (2006, p. 110) found that researchers can choose to combine multiple forms of data to account for "diversity of views," where qualitative data may help to explain or support questionnaire findings. The research has resulted in collection and analysis of data according to the methodology explained in the following sub-chapters.

3.2 Case Studies

Robson and McCartan (2016, p. 150) define case studies as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence." Case studies are considered part of a robust research design (Zainal, 2007) and furthermore, can enable the researcher to add to the existing research by providing areas of new research (Saunders et al., 2009). Case studies are useful when attempting to answer exploratory questions such those beginning with "How" and "What" (Saunders et al., 2009). With case study research, multiple sources of data are combined to give "strength to the findings," and "promote a greater understanding of the case" (Baxter & Jack, 2008, p. 554). For most case studies the triangulation of data is required and thus multiple methods of data collection are utilized in this research, including interviews, questionnaires, and secondary data (Saunders et al., 2009). For example, triangulation of data can be seen in the collection of data for this research from the use of semi-structured interviews, and by the utilization of a questionnaire with quantitative results to help support and validate the initial qualitative results (Saunders et al., 2009).

According to Yin (2009) and Saunders et al. (2009), multiple case studies are preferred to a single case study as they ensure that findings in one case can be applicable to another case, and finally to allow for generalization between those cases. The aim of this research study is to understand the specific factors companies are utilizing to enable value creation; therefore a multi-case study design is most relevant for this research. Furthermore, developing multiple case studies will give insights into the differences and similarities between the companies as well as among the various sectors. One singular case study with one company would not develop a comprehensive result and would be subject to bias and context of the sector and product or service that companies provides.

3.2.1 Case Study Companies and Scope

This research focuses on companies that participate in the circular economy and more specifically, those that are positioned in different parts of the CLSC. This includes both companies such as original product manufacturers (OPMs) that recover their own products, as well as third party companies whose main business model is to recover other companies' products (partially-closed loop). Most companies that participated in the research were located in Europe along with some in the United States. While some companies' headquarters exist outside of these boundaries, such as in Japan, the main company location where the interviewee was located was either in Europe or the U.S. The companies that were interviewed were located in the Netherlands, France, the UK, as well as in cities within the states of Illinois and Wisconsin in the U.S. In addition, the sizes of the companies vary from small (less than 50 employees), medium (50-249 employees), to large (greater than 250 employees). Most are categorized as large, but a majority of the startups are small companies. Furthermore, all companies are for-profit businesses, and none is considered a non-profit or governmental organization. Table 5 below gives an overview of the all of the companies that participated in the research as well as the categorization of the companies into their distinctive sector groups. Details for each company include information about the products, location (including headquarters), and finally the company size.

The companies span a variety of sectors including, electronics, manufacturing and machinery, flooring and insulation, office furniture, material handling and packaging, and startups. Each sector group comprises two to three companies on average, allowing for an objective comparison of each sector. Having these different sectors allows for a more detailed comparison of different types of raw materials or products. For the electronics sector, many companies' products use critical raw materials such as indium, which can be found in LCDs, could be completely used up within 20 years (EC, 2015; Cohen, 2007, as cited in Hobson, 2015). Furthermore, many electronic products that are comprised of hazardous materials end up as e-waste in landfills, which can cause negative environmental and health effects (Khor & Udin, 2012). The manufacturing/machinery sectors are critical for closing the loop, as they are known for high levels of material and energy use as well as significant waste creation (Ocampo & Clark, 2014). The flooring/insulation as well as material-handling/packaging sectors create many products that require large amount of plastic for the production of their products (e.g. plastic insulation, or returnable plastic packaging). Plastics are important to consider as the use of plastic is steadily rising in the European Union (EU), where about 25% is recovered for recycling and the remaining 50% goes to landfills (EC, 2015). Startups are important to address as many are small or medium sized enterprises (SMEs) that can make a significant contribution in the CE since they are key in creating new innovative business models within the service based economy (EC, 2015; EMF, 2015a).

Most of the case study companies are located in the EU, specifically the Netherlands, because the country holds a prominent place in the circular economy discussions and has developed strong collaborative relationships with the government to develop circular economy activities (Florin et al., 2015). The U.S. is also important to look at as a comparison to see if the same advances and activities are taking place.

3.2.2 Company Overviews

COMPANY	PRODUCTS	LOCATION	COMPANY SIZE
CATEGORY ONE: ELECTRONICS			
Canon	Printers & Cameras	Canon Europe London, Japan (HQ)	Large >250
Ricoh	Printers	Ricoh Europe France, Japan (HQ)	Large>250
Philips	Lighting & Healthcare	Netherlands (HQ), Global	Large>250
CATEGORY TWO: MANUFACTURING, MACHINERY			
Caterpillar	Heavy Machinery Equipment & Engines	USA (HQ), Global	Large>250
Ace Wikkeltechniek	Drive Remanufacturing	Netherlands (HQ), Local	Small <50
Mitsubish Electric Elevators Europe	Elevators	Netherlands, Japan (HQ)	Large> 250
CATEGORY THREE: FLOORING & INSULATION			
Interface	Carpet and Flooring	Netherlands, USA (HQ)	Large >250
Thermaflex	Insulation for Heating & Cooling systems	Netherlands (HQ), Global	Large >250
CATEGORY FOUR: OFFICE FURNITURE			
Gispen	Office Furniture	Netherlands (HQ), Global	Large >250
Ahrend	Office Furniture	Netherlands (HQ), Global	Large >250
Rework by ROE	Office Furniture	USA (HQ), Local	Small <50
CATEGORY FIVE: MATERIAL HANDLING & PACKAGING			
Monoflo International	Reusable Packaging Products	USA (HQ), Local North America	Large >250
Vanderlande	Conveyor & Baggage Handling Systems	Netherlands (HQ), Global	Large>250
CATEGORY SIX: STARTUPS			
CRS Holland	Cable Recovery Services	Netherlands (HQ), Global	Small <50
Gerrard Street	Headphones	Netherlands (HQ), Local	Small <50
Bundles	Washing Machine Leasing Service	Netherlands (HQ), Local	Small <50

Table 5. Company and Sector Overviews

3.3 Data Collection

To address the research aims, the developed theoretical model has been used as a tool to collect concrete and measurable data to determine results of how real-life case studies compare to the scientific theory. Data collection has been carried out through desk research, interviews and questionnaires, and by reviewing other sources of secondary data. These specific data collection methods were used to operationalize and give meaning to the components of the theoretical model as well as answer the research question and sub-questions.

3.3.1 Desk Research and Literature Review

Desk research was carried out both online and at Utrecht University for the development of the theory and background information. Online search engines such as electronic journals, online library catalog, Google Scholar, and Scopus were utilized to gather professional literature and other documentation. The program Mendeley was used as an organization tool to sort and categorize the various sources to establish an in-depth overview of the literature. Research online and at the University library was employed to understand the specifics of the various sectors as the background information on the case study firms before carrying out the interviews.

3.3.2 Interviews and Questionnaire

Interviews, such as qualitative research interviews, are critical for collecting accurate and reliable data (King, 2004; Saunders et al., 2009). In this case, semi-structured interviews were carried out to allow for interviewees to give open and detailed answers in a flexible format (Bryman, 2012). Saunders et al. (2009) explains that this format for the interviews enables the interviewer to leave out certain questions that may not apply to a certain organizational context. This was important for this research, as some of the interview questions did not apply to all companies. As an example, certain questions about recovery of produced products did not apply to certain third party companies that only recovered other companies' products. Interviews, conducted in English, were carried out with all of the case study companies. The interview questions were formulated to evoke responses that could be used for the creation of the case studies as well as to determine factor interactions. To address this, an interview guide was constructed including general interview questions (Appendix 2).

For the interviews, a total of 11 generalized questions were asked, and focused around the main research question and sub-questions. Accordingly, the questions covered topics and themes including: company details, history, interviewee role and function, recovery activities, sustainability in general, sustainable value concept, tools, methods strategies, and tools for sustainable value creation, challenges, and company next steps and goals for the future. This format allowed for the introduction of the research topic to the interviewee and created a more un-structured interview environment where open responses could be given without explicitly asking about specific factors. Since the research topic about factors and enabling SVC could be a very abstract concept for interviewees, questions were introduced in different ways to help avoid possible confusion about terminology and context. For example, bringing up the more general theme of sustainability

resulted in answers that gave information on enabling factors for SVC. Only one specific question within the interview focused on SVC and asked about different methods, strategies, or tools.

In total, 16 companies participated in the interview process and one person from each company was interviewed. The interviewee pool spans various roles and functions such as in the areas of: Sustainability, Corporate Social Responsibility (CSR), Legal, Environmental Health and Safety, Circular Economy, Sales, Strategy and Business Development, or Management. Refer to Appendix 6, Table 14 for a complete list of interviewees and the interview information such as company, position, time in position, date and location of interview, length of interview and interview transcript name. Interviews were conducted in-person, over the phone, via Skype, and through a written format. A majority of the interviews, 13 out of 16, were either in person, over the phone, or through Skype. The three remaining interviews were completed as a written response returned from the companies due to various reasons, including distance of location (outside of the NL) as well as conflicts in the scheduling of the interview or technological issues. The interviews ranged in duration from 36 minutes to 92 minutes with an average interview time of 61 minutes. Within this time frame, both the general interview questions as well as the questionnaire were addressed.

When carrying out exploratory mixed-method research it is useful to complement interviews with a secondary method such as a questionnaire, which allows for comparison of quantitative data, as well as an equal opportunity for response in a standardized format (Saunders et al., 2009). Furthermore, the authors state that questionnaires, also known as survey strategy, are most often used to answer "What" research questions, which in this study relate to the research sub-questions 1 and 2, of "Which factors" as well as factors relating to "Which factors within companies and between sectors." The questionnaire, which was completed during the second half of the interview process, corresponds directly to the theoretical model by addressing each of the 30 specific factors listed in the model (Appendix 1). While answer lengths could differ in the interview, in the case of the questionnaire, the items asked were in the form of "forced-choice questions" which forces the respondent to choose from a set of answers such as giving a ranking (De Vaus, 2002, as cited in Saunders et al., 2009; Saunders et al., 2009). Each factor was introduced to the interviewee, and a short explanation with examples was given to describe each factor. Each singular factor was represented by a specific line item in the questionnaire where the interviewee had to give a response that was two-fold. First of all the interviewee was asked if they recognized the factor in their value-creation process, and secondly, they were asked to give a rating to the factor. If the factor was recognized, then it was rated from a score of 1-10, with 10 being of high importance to enabling value creation, and 1 being very low for enabling value creation. If the factor was not recognized, then it was marked as not applicable and given a score of zero. Please refer to Appendix 3, Table 11 for a full overview of the questionnaire layout. For example, a certain interviewee may respond to recognizing mostly "Social-relational" factors and give them a high ranking, while at the same time may not recognize as many factors in the "Technological" factor category and give them a low ranking. The questionnaire enables the companies to give a score to these abstract concepts and can give a more precise response in regards to these factors.

3.3.3 Secondary Data

Secondary data, such as documentary secondary data (Saunders et al., 2009) includes both qualitative and quantitative information such as various documents, brochures, reports as well as other information gathered through the internet and websites. This secondary data was gathered to help frame and fill in any informational gaps in the case studies for each of the companies. Specific types of sources or documents that were referenced include sustainability reports, yearly reports, product and company brochures, environmental product declarations (EPDs), as well as the company websites. Other internet-based sources were also utilized including organizational websites such as Netherlands Circular Hotspot, Circle-Economy, MVO Nederland, Cradle-to-Cradle Products Innovation Institute, Ellen MacArthur Foundation (EMF), and The European Remanufacturing Network (ERN).

3.3.4 Development of Case Study Findings

The final case study findings resulted from the combination of the interview, questionnaire, and secondary data information. The main components of each case study overview include the following elements: [1] a summary and description of each company with facts and statistics, [2] which recovery loops they participate in, [3] current state and descriptions of recovery activities/loops, [4] tools, methods and strategies used for SVC, [5] current challenges each company is facing, [6] and finally an overview of the next steps for each company. The case study findings give an in-depth overview of each sector and which recovery loops the companies participate in. Furthermore, it creates a picture of the current state as well as the company's view and goals for the future. Most importantly, specific factors have been discovered that contribute to SVC that are specific to each case study company and sector. This data helps to answer the research question and sub-questions, supports the findings, and contributes to the development of final discussion points and recommendations.

3.4 Data Analysis

Both qualitative and quantitative data have been collected and analyzed. The qualitative data stemming from the transcribed interviews has been analyzed through the process of coding which categorized and distinguished the specific value-adding factors that were being addressed by each sector company. After the coding was completed, a figure showing the analysis of interactions between the factors was created. In addition to the coding analysis, graphical representations of the quantitative questionnaire data were compiled to give multiple perspectives of the data results. This includes comparisons of all listed factors, comparison of different factor categories, as well as a comparison between company sectors.

3.4.1 Coding of Interviews

All transcript data from the interviews have been organized within an Excel document according to a developed coding scheme based on specific categories derived from the theoretical model and corresponding factor tables from Appendix 1. A coding scheme is a logical method for categorizing data enabling comparisons of data (Saunders et al., 2009). Quotes have been coded utilizing the following categories to distinguish each

quote into: interviewee number, quote number, factor interaction number, factor code(s), and actual quote. This coding scheme provided a method to translate the responses of interviewees into data that was used to analyze existing factor interactions, thus giving an answer to research sub-question 2. Please refer to Appendix 4, Table 12 an explanation of how these coding categories correspond to the theoretical model and how they address the research aims.

See Table 6 below for coding scheme example:

Company# (Company Name)	**Factor Interaction**	**Factor Codes**	**Quote#**	**Quote**
1 Canon	1 Interaction between two factors	SR1	1	"Quote"
2 Ricoh	2 Interaction between three factors…	SR2	2	"Quote"
…	…	…	…	…
Examples:				
4 Caterpillar	1	SR2 & OP4	3	"We actually listen to the customer feedback, most of our new product introduction is driven by the customer saying, hey, I'd really like to have this."
8 Interface	1	SR1 & OP10	5	"I really also want to emphasize the relationship with our suppliers and the role our purchasing department has."

Table 6. Coding Example

3.4.2 Factor Analysis Resulting from Questionnaire Data

Specific figures and tables have been created to organize the questionnaire data into visualizations of results. The main figures that have been developed are based on the format and factor components of the theoretical model. This will allow for a direct link and comparison from the results back to the model for a clear and comparable graphic.

The types of graphical representations and figures that have been developed from the data include the following:

1. *Factors Interactions* -
   - First, a graphic has been created that shows all factor interactions. This includes interactions between factor categories and within factor categories. These interactions have been counted and totaled for each interaction type and has been summarized in Appendix 5. The results of this data answers research sub-question 2.

2. *Factor Rankings* –
   - Within this graphic representation, each of the 30 Factors have been given an average score between 1 and 10 according to the replies from each of the

companies. The resulting scores for each factor from each of the companies was combined and given a cumulative average score.

- This graphic representation allows for individual comparison of all factors by showing the highest and lowest ranked factors. This result helps to answer research sub-questions 1 and 3.

3. Factor Applicability –
   - This overview has been compiled into a table listing which factors are not applicable, mostly applicable, and always applicable from the questionnaire.
   - Factor applicability is important to address, as the factors were dependent on the score they were given, including the not-applicable categories, which were given a score of zero.
   - This was important as it gave each factor to receive a numerical ranking to allow for the calculations of the average scores that were given to the factors and categories. This information is summarized in Appendix 8.

4. *Factor Rankings within Each Factor Category* –
   - One figure has been developed that compares the four factor categories as a whole based on their cumulate average score.
   - Four additional figures have been developed to give an indication of which factors are most important within factor categories of Social/Relational, Technological, Operational, and Organizational.
   - These graphic representations allow for comparison between factor categories as well as within factor categories and further answers research sub-questions 1 and 3.

5. *Factor Rankings within Each Sector Type* –
   - Six figures have been compiled with the showing ranking order of each factor category from highest to lowest for each sector type.
   - This graphic representation allows for the comparison between the six different sectors and answers the second part of research sub-question 3 about sectors.

3.5 Limitations of the Methods

First of all, in terms of data collection, some limitations were encountered when searching for, and working with the case study companies. This included limits of accessibility to certain types of companies and sectors as well as specific employees for the meetings or interviews, which was in part due to the time limitations for the thesis research. 16 companies in total were included in the research; however, a more wide variety of sectors, such as those in the food, chemical, or fashion or textile industry would have been interesting to include in the results. In addition, most companies that were interviewed were either manufacturers or third-party companies, and it would have been interesting to also look the perspective of circular organizations (i.e. Nederland's Circular Hotspot) or the government. Availability of certain interviewees was also a minor limitation, as 3 out of the 16 companies submitted a written response due to constraints in time, location and technology such as having no access to Skype. However, in the end, the required information was gathered through the written format through email, and follow-up questions were sent to each company in order to develop the needed information for the case study summaries. When certain information was not available, company documents, brochures, and websites were utilized to fill in the gaps missing in the information.

Second, during the interviews, the possibility of subject or participant bias and subject or participant error could have been encountered (Saunders et al., 2009). An example of bias within the interviews may have been by differing viewpoints of both the interviewer and interviewee of sustainability and specific terms (Lozano, 2013). A secondary bias that may have been encountered was in terms of one interviewee answering questions that spanned multiple topics for many different company departments or functions. Statements may have been made on other employees' behalf on the topic, which could have led to a bias on the interviewee's behalf. It is not to say that the interviewee was not informed on these items, but it would have been beneficial to also include other functions. Subject or participant errors may have occurred that could have led to miscommunication or misunderstandings between the interviewee and interviewer since the interviews were conducted in English.

Third, some uncertainties about the questionnaire questions also arose during the interview process. In some cases questions came up about the questionnaire regarding the context or meaning of certain items, and further explanation and detail were given to provide clarification. For example, some of the interviewees commented that they felt that the questionnaire was lacking a time dimension. Some interviewees felt that some factors would be more applicable in the future. Therefore, to clear up this confusion, it was established for each interview that the questionnaire was framed to be in the current working environment for the current state of the business. Furthermore, some of the information that was categorized by the interviewees as being important in the future was explained in the "Additional Findings" section of the case study sector findings sub-chapters.

While the methods were designed to be robust in answering the research questions, possible limitations could have been encountered that may have impacted the data analysis process. A first limitation that may have occurred during the development of the case study findings could have been that some of the responses may have been shortened or

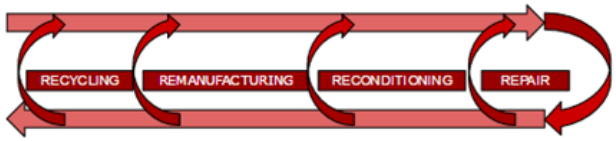
summarized, when more detailed answers were given during the interview itself. This has been addressed by ensuring that full transcripts are available upon request. Second, since this case study and data collection focused on only internal actors within companies, the consideration of viewpoints and perspectives of outside actors, such as suppliers, customers and other stakeholders is limited. Therefore, based on the results, generalization and applicability to other sectors or companies may be restricted (Saunders et al., 2009).

4 Case Study Findings

The following sub-chapters include case studies developed according to sector and have a separate case study summary for each company within that group. These case studies include information gathered from the responses to the eleven interview questions, as well as company documents and other online data sources. The case studies have been organized into sections, or boxes, that address each company's specific recovery activities that they participate in, current state and description of recovery activities, tools, methods and strategies that enable sustainable value creation, challenges the company is facing, as well as the company's next steps and future goals. Each sub-chapter for each sector concludes with a comparison of the similarities and differences of the responses of those companies within the sector in regard to the recovery loops, factors, as well as a summary of additional findings. Additionally, within each of the case studies, in the top right hand corner, there is a small graphic representation of the closed-loop system that was visualized in section 2.2.1 (Figure 5) of the theory section. This figure has been modified to each specific case study to give a clear picture of which specific recovery loops the companies are participating in.

The majority of content within each case study is a summary of the statements made by each of the interviewees themselves and all remarks or opinions are strictly based on the interview responses. Appendix 7 includes full details all of the sources, citations, or additional information that was used to develop each case study including the information listed in the short company overview "box" at the beginning of each company introduction, such as the number of employees or information about the types of certifications or partnerships.

4.1 Case Study Group One - Electronics Sector

Location: London, Japan (HQ) ***Number of employees***: Approx. 10,000+ ***Founded***: 1937 ***Products/Services***: Printers, Electronics, Cameras	 Canon participates in all recovery loops. Main focus is on FPNM range for remanufacturing as well as cartridge recycling.
Sustainability Reports or Documents: Sustainability Report 2015, EMEA Sustainability Report 2013 ***Initiatives or Partnerships:*** European Remanufacturing Network (ERN) ***Certificates or Certifications:*** ISO 9001, ISO 14001	***Quote:*** *"*Sometimes companies and designers should be held more accountable for their design choices, you need to look at the system systemically, and go really from the very beginning from sourcing, to manufacturing then to end of life systems."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
If machines are still in proper functional and working condition they can be re-used. With these types of machines Canon has a spare parts program, where the customer has a service agreement where service engineers come out to fix and maintain machines and replace parts if needed.	Canon has field replacement units, which are utilized for more extensive repairs or refurbishment activities where an entire part or module of the printer needs to be changed out such as a motor.	Remanufacturing takes place in Giessen Germany, the central repair center, where suitable printer products become part of the factory product new models (FPNM) range. When units come in they are cleaned, repaired, updated with new parts and are updated to comply with current standards. A completed FPNM functions the same as a new model, but at a reduced price.	Cartridge recycling process has been carried out in France since 1990. Globally over 24 countries have a cartridge recycling program and the benefit is that a majority of the material is reused, with the exception of the addition of some virgin material.

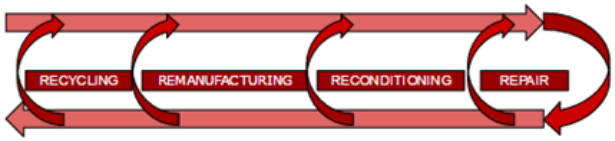
Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- A focus group centering on the Circular Economy and sustainability meets on a quarterly basis and comes together to solve problems and collaborate on initiatives. Additionally, there are dedicated groups and departments that work on improving reverse logistics and the spare parts activities.
- Canon participates in auditing activities for their ISO 14001 certifications both internally and externally.

Challenges:

- There are some internal perceptions on the terminology relating to the circular economy, and it can be quite difficult for employees and other stakeholders to understand the importance and their specific role. In some cases the subject matter can come seem very abstract and academic and the goal is to make it more approachable for everyone within the company. The company is very big and it is hard to really get things set in motion.
- The FPNM range is not as well-known as the cartridge recycling activities. Furthermore, the remanufacturing activities are applicable to most Canon models but not all due to the capacity constraints in Giessen. Also, with refurbishment, after a certain amount of time, spare parts are no longer available for certain models.

Next Steps: The next steps for Canon include increasing collaboration between departments as well as taking advantage of new technologies including big data and data analytics.

RICOH ***Location***: France, Japan (HQ) ***Number of employees***: Approx. 1,000+ ***Founded***: 1986 ***Products/Services***: Printers, IT and Document Management Services	 Ricoh participates in all recovery loops. Main focus is on Green-Line™ remanufacturing program as well as printer component recycling services.

Sustainability Reports or Documents: Sustainability Report 2015 ***Initiatives or Partnerships:*** European Remanufacturing Network (ERN) ***Certificates or Certifications:*** ISO 9001, ISO 14001, ISO 27001	***Quote:*** *"*Every actor of the supply chain and reverse logistic is responsible inside the virtuous circle of resources we are implementing (collectors, sorting center, remanufacturing, sales man, technical center). Value is created at every stage."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Printed circuit boards are repaired at the Ricoh facilities. In addition, used cartridges can be re-used after cleaning, and are refilled.		GreenLine™ remanufacturing program for multi-function printers involves cleaning, erasing former data, replacing damaged parts, updating software, as well as ensuring like new product with conformity a specific standard. Also, Ricoh collects used toner cartridges through the Ricoh Comet Circle™ programme for remanufacturing.	Printed circuit boards and photo conductor units are recycled. These product wastes are either disposed of by third-party recyclers or used as an energy source. Ricoh has a zero waste to landfill policy.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Ricoh believes that developing partnerships with various parties, throughout the entire product life cycle is critical. One example is that the company is working with other manufacturing companies to reduce the amount of hazardous substances in their materials and parts.
- When multi-function printers go through the remanufacturing process in the GreenLine™ program they are certified externally to the BSI 8887-220 standard in order to guarantee new warranties for the remanufactured product. The relationship with the customer is also critical, and meeting these standards and proving the GreenLine™, allows Ricoh to give confirmation that they are working on meeting their sustainability goals.
- Product design and a focus on eco-technology are important, such as design for reuse, recyclability or remanufacturability.

Challenges:

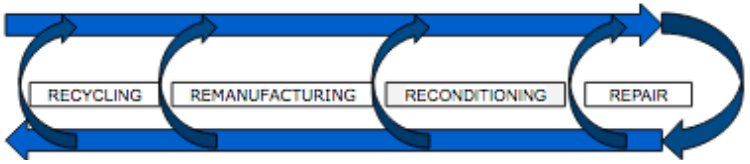
- Employee mindset regarding the model of the CE is not yet well accepted by employees, who are more familiar with the traditional production processes regarding new equipment. Overall, people need to understand that waste is also a resource and to be convinced to support new changes concerning the Circular Economy.
- Overall Ricoh is facing different types of challenges including, finding solutions to technical issues, addressing employee mindset and culture, unclear or inconsistent legislation put forth by the EU, market issues such as competition, and general organizational issues regarding new considerations for safety, skills, and jobs.

Next Steps:

- Ricoh plans to continually improve waste recovery and recycling through the development of new technical solutions.
- Furthermore, Ricoh aims to optimize its reverse logistics by allowing increased volumes for recovery, reducing costs as well as well as a reduction in carbon emissions.

PHILIPS

Location: Netherlands (HQ), Global
Number of employees: 100,000+
Founded: 1891
Products/Services: Healthcare, Lighting, Consumer Products



Philips participates in all recovery loops. Main focus is on leasing systems, and service contracts (Lighting) as well as refurbishment and remanufacturing (Healthcare).

Sustainability Reports or Documents: Annual Report 2014, Sustainability & Circular Economy Brochures, Sustainability Case Studies, Sustainability and Environmental Policies
Initiatives or Partnerships: MVO Nederland, European Remanufacturing Network (ERN), Ellen MacArthur Foundation Circular Economy 100, Netherlands Circular Hotspot , World Economic Forum
Certificates or Certifications: ISO 9001, ISO 13486, ISO 14001

Quote: "A sustainable world for me is when you have nine billion people all enjoying a healthy and fulfilled life on the planet that we have in harmony with the biosphere. So this is for me sustainability and circular economy has the potential to decouple the development and the resource increase."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Leasing contracts are in place for the healthcare equipment where the customer does not own the product but has all of the benefits of the product. (Not yet as developed for the lighting systems). Service contracts for large healthcare equipment take advantage of Philip's parts harvesting activities where used parts are gathered from refurbishment activities.	Refurbishment is not yet being done in the lighting sector, but has been an active form of recovery for over 20 years in the healthcare space. Products are tested, upgraded, and repaired with spare parts from previous refurbishment activities. Products are also upgraded to the newest technologies to ensure multiple life cycles and high functionality.	Products are remanufactured when they are no longer suitable to be refurbished. These products are completely overhauled and upgraded to the latest technology and also go through an outer cosmetic upgrade.	If parts cannot be refurbished or remanufactured, they are taken apart and separated into base materials at Philips facilities. Philips then works to get the components back to original material streams through agreements with multiple recycling partners.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Specific tools such as quality tools could be applied to sustainability and circular problems, but need to be applied and used in a new way to provide new insights.
- Partnerships are being formed with multiple companies with regards to recycling, which have helped to overcome barriers associated with recycling. Philips has not yet been able to determine how to recycle materials individually in a cost efficient way so these partnerships are essential.
- Product design and eco design considerations are important to Philips such as innovating for modularity, upgradeability, and finally recyclability. This will enable maintenance and service on products, which Philips believes can be highly valuable.

Challenges:

- The current mindset of the employees and customers is a challenge, and education is needed to show examples of the benefits. Once people see and successful examples and are educated, such as through training, Philips feels they will become more interested willing to participate.
- Customers need to be more informed about Product-Service Systems (PSS), and hopefully in the future, customers will demand it more and accept it more readily.

Next Steps:

- Product stewardship is the main goal for the future, where products that are made by Philips would return to the company so that they would have control over the entire life cycle of the product.

4.1.1 Electronics Sector Findings

Recovery Loops

The electronics sector is comparable in that they all seem to participate in all four types of recovery to a certain degree. The main focus of most of the organizations is on leasing, maintenance, repair through the utilization of spare parts, as well as remanufacturing for multi-function printers. Cartridge recycling is also a main point of focus for Canon and Ricoh for the consumer market as well as other printer components such as circuit boards. Companies are beginning to move in new directions and are developing new business models, such as Philips' "Lighting as a Service," which is not yet as developed as some of the printer programs or consumer-led initiatives. One point of future attention is to overcome barriers associated with capacity and costs in regard to remanufacturing processes in order to increase the number of products that can be remanufactured.

Factors that Enable SVC

The main business models such as leasing help to keep the product within the scope of the companies in order to keep control and monitor the life of the product. They also help to lead to longer life-cycles through continued maintenance and repair. Partnerships, especially long-term relationships, are being formed with supply chain actors in order to facilitate returns, as well as special collaboration for logistics partners in order to enable the proper recycling of multiple material streams. Product design is an important factor that the electronics sector companies are addressing such as eco-or design that considers the EOL for products such as design for remanufacturability or recycling. Lastly, quality methods and tools such as auditing suppliers for ISO certifications as well as other value-mapping tools are being modified to address circularity and sustainability.

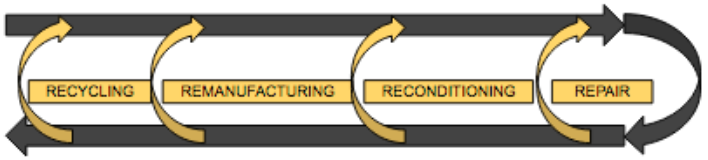
Additional Findings

The companies in this sector are dealing with similar challenges in regard to employee and customer mindset and are working on communication about the circular economy initiatives and the benefits of product-service based systems. The sector companies all have a focus on sustainability, as reflected in their sustainability reports. Additionally, they all participate in various industry or circular economy organizations and two of the companies are involved with the new European Remanufacturing Network. Two of the companies are also encountering issues with product obsolescence, where after a few years certain spare parts are no longer available for repair or remanufacturing purposes. For the future, the sector wants to make improvements in reverse logistics and update their technology solutions.

4.2 Case Study Group Two - Manufacturing/Machinery Sector

CATERPILLAR

Location: Peoria, IL, USA (HQ), Global
Number of employees: Approx. 10,000+
Founded: 1925
Products/Services: Constructing & Mining Equipment, Engines, Machinery



Caterpillar participates in all recovery loops. Main focus is on remanufacturing systems.

Sustainability Reports or Documents: Sustainability Report 2015
Initiatives or Partnerships: Ellen MacArthur Foundation, Remanufacturing Industries Council
Certificates or Certifications: ISO 9001, ISO 14001

Quote: *"*So our goal in Sustainable Development is to improve systems, reduce waste, and improve both the lives of our customers, and the lives that our customers impact. And we think that we can do that more efficiently than anybody else in the market."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING✔***
CAT dealers are officially authorized servicers for equipment. They have access to all the tools, diagnostics and factory specs to do maintenance, repairs, and overhauls (refurbishment) to the CAT products. If a product is unable to be put back to original specs it is sent to a CAT remanufacturing facility.		CAT remanufacturing is an exchange business where customers return their core when purchasing a remanufactured product. A deposit is held until the core is returned. The remanufacturing process consists of disassembly of components, 100% inspection, verifying original tolerances, additive manufacturing when needed to return to original specifications, assembly, test and verification of each product. Furthermore, the remanufactured product has a guarantee that it will operate like-new and comes with a warranty that is the same as a new part warranty. Cat guarantees a remanufactured part will operate the same as a new part, or better.	Internal recycling for CAT's manufacturing processes is done through their own foundry where they recycle metal materials. However, external third party recyclers pick up most of the materials that are available for recycling. For customer-owned equipment, the customer may return it to the dealer, trade it in, but often is sold to a third party recycler to be disposed.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Engineers work to improve design of products for remanufacturability, and for EOL considerations. CAT equipment is also designed for efficiency for loading and hauling.
- CAT has partnerships with their suppliers for their end of life materials to be raw material suppliers for those companies such as for brass bushings.
- Newer CAT equipment is upgraded with new electronic technologies and diagnostic equipment that can send data information to the dealers and facilities on usage and also gives early warning indicators to address problems proactively.
- Customer collaboration and input on product design and development stages are very important for CAT, especially during new product introductions (NPIs). Customers can give feedback on what they would like to see in new designs and can give input on certain engineering improvements or changes.

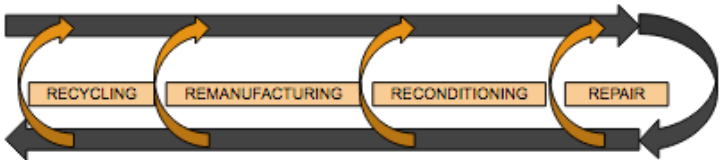
Challenges:

- Due to the increased popularity of remanufacturing, many companies are claiming their refurbished products are remanufactured. This creates issues for CAT when they sell remanufactured products globally, since there is no clear language or guidelines for governments to distinguish between remanufactured products and refurbished.
- Plastic gauges and other plastic components that are found in the newer equipment make it more difficult to recycle them in normal recycling streams.

Next Steps:

- Next steps include continuing and expanding the dialogue with the government and other parties concerning remanufacturing legislation.
- In the future, CAT wants to continue to add more part numbers that are available for remanufacturing in order to expand the business.

Location: Netherlands (HQ), Local
Number of employees: Approx. 12
Founded: 1979
Products/Services: Electro-Mechanical Equipment Remanufacturing



ACE Wikkeltechniek participates in all recovery loops. Main focus of ACE Re-Use Technology is Remanufacturing.

Sustainability Reports or Documents: N/A
Initiatives or Partnerships: MVO Nederland, European Remanufacturing Network (ERN)
Certificates or Certifications: ISO 9001, ISO 14001

Quote: "We sincerely believe that our world will transform from a linear economy to a circular economy. We believe that remanufacturing is one of the main pillars for this circular economy."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
ACE repairs, refurbishes, and remanufactures products including electrical engines, gear-boxes, and pumps for their customers. Customers deliver their products to ACE, who acts as a 3rd party remanufacturer. Through ACE Re-Use Technology the company remanufactures drives where they are upgraded to modern standards and meet original part specifications.			From the recovery flow that comes back 95% goes back to the customer as repaired, refurbished, remanufactured product, with 5% going as waste to the recycler.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- ACE works to get the message out about remanufacturing and its benefits to get potential clients for new remanufacturing business.
- Collaborating with OEMs to meet their remanufacturing needs creates cost-savings for the customer. Remanufactured drives are upgraded to the same quality as a new drive, but at a much lower cost.
- Remanufacturing helps to avoid the use of critical raw materials, as well as copper and other metals.
- When remanufacturing parts, ACE takes the time to investigate structural damage of components on a large scale and works to improve the overall design for the future.
- A special logo is utilized on the remanufactured drives and shows "Remade in Holland" which helps to communicate the remanufacturing activities.

Challenges:

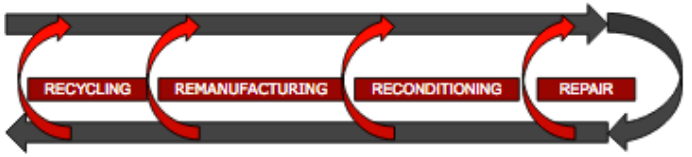
- There is a gap between the idea of the circular economy and the actual practice of making the circular economy a reality.
- Reverse logistics including transport and supply chain considerations are a challenge for ACE.
- Future design of motors and electromechanical products need to account for design for disassembly as well as durability. ACE has formed partnerships with OEMs to make design changes and collaborate with them to implement the new designs.

Next Steps:

- Updates in the production processes and improvement of robotics are key to long-term success.
- In the future, steps need to be taken in regard to national and local regulations regarding remanufacturing standards.
- ACE wants to continue to pursue new partnerships within their networks to grow the remanufacturing services they provide in order to get new clients.

MITSUBISHI ELECTRIC
MITSUBISHI ELEVATOR EUROPE

Location: Netherlands/Belgium, Global
Number of employees: Approx. 190
Founded: 1951
Products/Services: Building Materials, Elevators



Mitsubishi Electric participates in all recovery loops. Main focus is M-Use® program with a leasing & pay-per-use system.

Sustainability Reports or Documents: N/A, Sustainability Overview on Website
Initiatives or Partnerships: Founding Partner Park 2020, Netherlands Circular Hotspot, Dutch Green Building Council, M-Use® Program
Certificates or Certifications: ISO 14001 [C2C and FIRA Platform- Future considerations]

Quote: "Improving the expected lifetime of components through product design and maintenance schemes is the first and most important step. Staying out of the recovery-loops as long as possible is the highest form of recycling in our opinion."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
M-Use® or "Mobility-Use," which is a program launched this year, involves a 20+20 year contract with a fixed yearly payment with additional pay-per-use as needed. The company is full-service organization that deals will new installations, maintenance, repairs and upgrades as well as EOL replacement of the entire installation. Since the program was just launched, the first recovery will be expected in the year 2025, with repair, refurbishment, and replacement of components such as electronic circuit boards, other metal components, and batteries using material passport.			Recycling will be done with partnerships for waste collection and reverse logistics where the entire installation can be removed, and materials such as the chromium stainless steel will be recycled.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Mitsubishi is promoting the use of goods over ownership in their pay-per-use and leasing model with M-Use® program.
- The new M-Use® elevators will have special sensor and data collection system that will help to gather information on the usage of the elevators throughout the life in order to enable a better system of maintenance and repair which will help to extend the overall life of the product and components.
- A critical aspect that Mitsubishi is addressing is the removal of the elevator systems at EOL. Their R&D and engineering groups are working on improving the Design for Disassembly to enable more efficient removal of the systems for recyclability and reuse.
- Through a learning curve with IBM (GARS Project) Mitsubishi is implementing a Remote Monitoring project to understand technical life-cycles of components and how to optimally apply them in different parts of the system.

Challenges:

- Challenges exist in developing the infrastructure of the recovery loops and reverse logistics systems. Material tracking will need the collaboration of other parties in the chain to make create an effective system that is easy to control.

Next Steps:

- Future goals for Mitsubishi include continuous improvement of their product designs, material choices, as well as the entire infrastructure of their supply chain and location of resources.
- In addition, they want to further develop the technological aspects of their products in order to enable a longer life-cycle to help avoid the recovery loops altogether.

4.2.1 Manufacturing/Machinery Sector Findings

Recovery Loops

The Manufacturing and Machinery sector participates in all four recovery loops; however the main center of interest seems to be on remanufacturing. For Caterpillar and ACE Wikkeltechniek, who deal with engines and other electro-mechanical products, remanufacturing is the main focus of the business, but they also repair and refurbish products. For Mitsubishi, the elevator systems also include remanufacturing services, but the company is currently concentrating on promoting a new pay-per-use model for the continuous repair and maintenance of the elevator systems. Recycling for the companies can vary from some being processed internally during manufacturing, all the way to materials being picked up by third party recyclers for metals such as those used in the elevator systems that are removed from installations.

Factors that Enable SVC

For both Caterpillar and ACE, ensuring that parts are remanufactured to original specifications and are given like-new warranties is critical for their products. They employ the same level of attention to quality and standards, even though one remanufactures its own products, while the other is a third-party remanufacturer. All of the companies are concentrating on the product design, especially the design for disassembly to enable them to effectively be reused, remanufactured, or recycled. Furthermore, both Caterpillar and Mitsubishi are employing new sensor and monitoring technologies in order to gather information about product usage, maintenance needs, as well as possible opportunities for improvements.

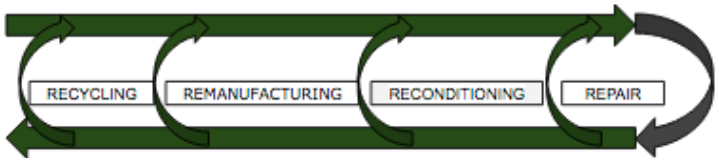
Additional Findings

Some of the challenges the companies are facing include reverse logistics and how to optimize the flow of return products within the supply chain. Mitsubishi specifically commented on the importance of "staying out of the loops" as long as possible through maintenance and product design. Caterpillar is also working on clarifying specific language about remanufacturing for both the industry and for regulatory reasons. They want to ensure that remanufactured products are not placed in the same category as repaired or refurbished items and are in a separate class where they are considered the same as "new." In the future, the companies want to continue to improve product design, improve technological aspects of their processes, as well as gain new clients for services such as remanufacturing.

4.3 Case Study Group Three – Insulation/Carpet

Interface®

Location: Netherlands, U.S. (HQ)
Number of employees: 285 (NL), 3500+ (Global)
Founded: 1973
Products/Services: Flooring & Carpet



Interface participates in all recovery loops.

Sustainability Reports or Documents: Annual Report 2015
Initiatives or Partnerships: Net-Works program™, MVO Nederland, Netherlands Circular Hotspot, The Natural Step Organization, Biomimicry 3.8
Certificates or Certifications: ISO 9001, ISO 14001, CRI Green Label, NSF 140-2007

Quote: *"*I think it's really important and really underestimated that you build upon the relationships with your suppliers or your customer so you can make a more solid ecosystem."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Customers are given advice on general maintenance, however if the carpet is in need of a deep cleaning, Interface has partners that can carry out this task. Also, the carpet can be replaced if it can no longer be cleaned.		Carpet tiles are taken back through Interface's Re-entry program. Interface works with a hub in Veenendaal where employees with a distance to the labor market sort the carpet for reuse. However for the carpet to be reused, it must be remanufactured which includes cleaning and taking additional steps to check the carpet to original specifications.	Recycling is partially done in-house, where the carpet materials are split into the yarn and backing. Yarn is processed together with the fishnet material to create new yarn and the backing material can be reused within the Interface production processes.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Product design and innovation is reflected in their products such as the glue-free carpet tile system with "gecko inspired patch" that allows the carpet to be reused without cleaning the tile or floor. Life Cycle Assessments (LCAs) are also carried out as well as the creation of Environmental Product Declarations (EPDs).
- The Net-Works™ program where the company sources fishnets from the Philippines has enabled the company to find a unique source of nylon, while also benefiting the local community and environment. Interface also participates in other cooperative relationships with NGOs such as the Zoological Society of London.
- The role of the purchasing department and the relationships they build with their suppliers is important to the company. The purchasing role has expanded to be more like project management, for example, through co-creating with suppliers to come up with new sustainable and innovative solutions for bio-based products.

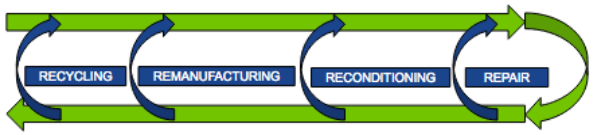
Challenges:

- Increased demand for bio-based products has led to the target of increasing the combination of bio-based and recycled materials in their products from 50% to 100% in the next four years.
- When recovering materials from construction sites, often the carpet is full of dust or other contaminants. This can be a challenge when processing carpet for recycling.

Next Steps:

- First of all, Interface wants to meet their 2020 goals and come as close as possible to being 100% circular.
- The long-term goal of the company is to move from being a restorative company to a regenerative company through strategies that go beyond 2020.

Location: Netherlands (HQ), Global
Number of employees: 80 (NL), 400 (Global)
Founded: 1976
Products/Services: Heating & Cooling Networks, and Technical Insulation Materials



Thermaflex participates all loops. Main focus is mostly in repair for reuse, and recycling.

Sustainability Reports or Documents: Environmental Product Declarations (EPDs), B- Corp Assessment
Initiatives or Partnerships: MVO Nederland, RACE Program through Circle Economy
Certificates or Certifications: Cradle to Cradle (C2C), ISO 9001, ISO 14001, B-Corp

Quote: "Thermaflex is a family-owned company and that leaves the owner thinking: What do I leave behind for the future generations? There comes the responsibility, which is one of our key values or fundamentals of being open and honest, responsible, and innovative."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
When un-used insulation material or "rest-lengths" are returned from customer networks from installation projects, they can be reused or refurbished into new custom lengths and re-sold for use in prefabricated solutions. Most of these insulation networks were produced and installed less than 15 years ago; therefore they are still in place. The usual life-span for insulation networks is 50-100 years, so repair, maintenance and reconditioning or reuse activities will increase once the insulation reaches its EOL. Furthermore, repair and maintenance activities are low due to the type of materials the company uses.		Remanufacturing is done when excess materials are used to build networks of pipes for unique applications like hockey field separations.	The main focus for Thermaflex is recycling. 75% of in-house materials are recycled, and the remaining 25% goes to external companies as a by-product to be used in other products or for other recycling streams.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:
- Packaging plays a role in the return of rest-lengths. Specially designed boxes enable the installers to return their unused products to recycle or reuse them.
- Fostering innovation and working together with new partners is important, especially creating new collaborations with key actors that they may not have worked with before. The company has joined together with other companies and the government to participate in the RACE program (Realization of Acceleration towards a Circular Economy) overseen by the Circle Economy cooperative.
- Some specific tools or strategies used to create value include: Cradle-to-Cradle certified products, life cycle thinking, Life-Cycle Analysis (LCAs), Environmental Product Declarations (EPDS), and the company being certified as a B-Corp in Northwest Europe.

Challenges:
- One of the biggest challenges concerns technical feasibility. There can be issues with plastics as they age over time and when they are returned, they are usually dirty or damaged due to the fact that they are behind building walls or come from demolition sites.
- Financial challenges, including the costs and investments involved to remain the sole owner of the materials within the recovery system, can have large impact.
- Policy changes are needed to clarify how circular procurement fits into the bidding processes for government products.

Next Steps:
- Thermaflex would like to focus on R&D as well as collaboration between multiple parties in the future to determine what the challenges are and what possible opportunities for improvement exist. This includes suppliers, customers as well as other supply chain parties not only in the Netherlands, but also within other countries.

4.3.1 Insulation/Carpet Sector Findings

Recovery Loops

For the Insulation and Carpet sector, both of the companies are concentrating on all of the four types of recovery. For both companies, if products are no longer usable, often times they are recycled in house, with some smaller amounts being recycled through a third-party company. However, the companies differ when it comes to maintenance and repair. For Interface the goal is to make sure to properly maintain and manage the upkeep of their products to enable the longest life-span. However, for Thermaflex, the main business activities include manufacture, prefabrication, and proper installation of the products. These types of materials are usually not "maintained" as they stay as part of their environment (buildings) until end of life when they are either re-used for new products or recycled.

Factors that Enable SVC

Innovation is a critical factor when making changes to increase the circularity of their products. This can be seen in both of the companies' efforts to collaborate with new partners in completely new areas such as Interface and the Net-works program in the Philippines and bio-based product partnerships, as well as Thermaflex and their collaboration with the government and other companies in the RACE program. Purchasing is also a critical factor for Interface, where they work to co-create with their suppliers to improve the circularity of their products. One major point of interest for both companies is that they focus greatly on their products for example Thermaflex, through Cradle-to-Cradle (C2C) certifications and environmental product declarations (EPDs), and Interface, which is working to replace their products with bio-based or recycled alternatives. Lastly, both companies are involved in partnerships with MVO Nederland as well as the Circle Economy and Netherlands Circular Hotspot initiatives.

Additional Findings

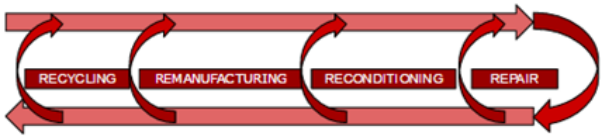
Both companies are encountering the same challenge of product and material quality after the use phase, where the carpet and insulation materials are often recovered from building demolition sites and are often covered with contaminants and dirt. Thermaflex specifically mentioned that when addressing innovation in terms of enabling SVC, companies should also focus on new business model opportunities, which is reflected in the fact that the company is B-Corp[3] certified in the Northwest Europe.

[3] Benefit Corporation - http://bcorporation.eu/what-are-b-corps/the-b-corp-declaration

4.4 Case Study Group Four – Office Furniture Sector

Gispen

Location: Netherlands (HQ), Global
Number of employees: Approx. 300
Founded: 1916
Products/Services: Office Furniture, Interior Design, Office Solutions



Gispen participates in all recovery loops.

Sustainability Reports or Documents: Environmental Statement 2014
Initiatives or Partnerships: Use-It-Wisely Project Industry Partner, TNO Partnership, Green Deal Network, MVO Nederland
Certificates or Certifications: EMAS, ISO 14001, ISO 9001, ISO 26001

Quote: "You need success, share it, make sure that everyone knows the benefits that you created with a project [...] make sure that everyone that is part of that process gets credited."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Part of established business model – maintenance and repairs are included in initial contracts.	Furniture is refurbished and upgraded when certain parts of the furniture need to be replaced such as the seating or upholstery.	Remanufacturing is done when furniture is transformed into an entirely different product with a new purpose, such as taking a closet and transforming it into a seating lounge. All of the parts and mechanisms of a product are checked to ensure they are up to original standards or qualitatively the same as new furniture.	Internal recycling is already being done. Gispen would like to find new places for their outflow of products to be an input flow of materials for other companies through industrial symbiosis.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Focusing on employee retention or empowering them to participate on improvements. The company emphasizes showing successes and sharing them with others. Once employees understand and are convinced that there is value in an initiative, Gispen can then begin implementing sustainability methods and tools.
- Gispen has partnered with TNO to create a scoring design framework for product design criteria. Gispen implements this method for their supplier management to determine and evaluate claims of product sustainability. This gives a score for the product that Gispen can include in their overall sustainable product package.

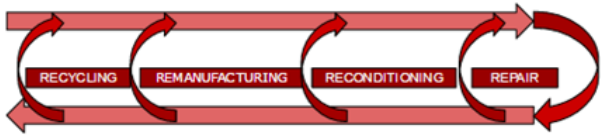
Challenges:

- Optimization within the facilities is needed, where the focus on updating the layout of the factory from a linear structure to enable reverse flow of materials is key.
- Employee mindset and culture is deeply ingrained, as some people have been working at Gispen for a very long time.
- Addressing storage capacity in the future for furniture that is taken back can also become a costly undertaking.
- Interaction with both suppliers and customers can be difficult. Getting suppliers to contribute and interact in different areas such as product design innovation as well as motivating customers to work together on problem solving are also major points of attention.

Next Steps:

- Developing the organizational structure, functions, and culture as well as optimizing IT.
- Upgrades will allow the company to enhance circular systems with the goal of embedding these processes into the organization.

Location: Netherlands (HQ), Global
Number of employees: Approx. 1800
Founded: 1896
Products/Services: Office Furniture, Education & Healthcare Furniture, Work Environment Design



Ahrend participates in all recovery loops. Main focus is on Ahrend Hergebruik or repair and reuse.

Sustainability Reports or Documents: N/A
Initiatives or Partnerships: MVO Nederland, C2C Partnership with Van Gansewinkel
Certificates or Certifications: Cradle to Cradle (C2C), ISO 26000, ISO 14001, FSC & PEFC Wood, EMAS

Quote: "Sometimes people think sustainability is the end goal, but it is the path or the way you are walking."

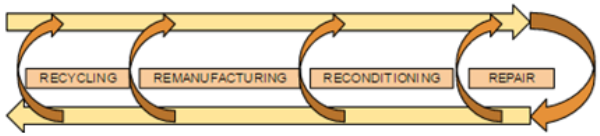
REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Ahrend Hergebruik, or Ahrend Reuse, promotes the upgrade and repair of furniture. Leasing program includes continuous maintenance to emphasize importance of use over ownership. Within this system, refurbishment and remanufacturing also may be carried out. Reconditioning activities involve a partnership with Alvero who has a full service operation for logistics. Remanufacturing is usually carried out when furniture needs a new function or design, and those products come with an Ahrend guarantee.			Recycling is carried out through Van Gansewinkel Group with two employees working permanently at Ahrend, who help to recognize process improvements or product design recommendations for improved recyclability of materials.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:
- C2C certification has been a big driving force in creating sustainable value.
- CSR Ambassadors are viewed as the "conscience of Ahrend." Ambassadors are involved in multiple departments and help keep track of sustainability initiatives.
- Ahrend also participates in initiatives such as DBFMO projects (Design, Build, Finance, Maintain, and Operate).

Challenges:
- Awareness and knowledge of what is happening in the loops. Informing customers of options such as leasing agreements or pay-per-use contracts.
- Logistics can be complicated - Recyclers require a large volume of materials to be collected at one time for it to be economically and practically feasible.
- Return volumes are not steady at the moment because products may still be at a customer location. In addition, furniture is sometimes collected by customers through the utilization of their own personal depot for reuse of the furniture internally.
- With logistics comes labor and time for disassembly, where the time and money spent on taking apart the furniture is usually higher than the value of the materials.
- Current low prices for raw materials for the furniture production take away the incentive to use recycled materials.
- Supplier agreements and purchasing contracts can become complicated when accounting up front for the complexity of component materials for end-of-life recycling.

Next Steps:
- Investigation into technical aspects and feasibility of recycling and the avoidance of downcycling. Find new avenues for recycling materials such as wood.
- Research and innovation, outside of the normal business practices. Partnerships even with competitors are becoming crucial to overcoming the challenges of costs of warehousing and volume requirements from the recyclers.

Location: Chicago, IL, USA (HQ), Local
Number of employees: Approx. 90
Founded: 1994
Products/Services: Office Furniture, Corporate Facility Services



Rework by ROE participates in all recovery loops. Main focus is reuse and refurbishment.

Sustainability Reports or Documents: N/A, Rework & Regroup Brochure
Initiatives or Partnerships: Chicago Community Involvement for Furniture Donations
Certificates or Certifications: N/A

Quote: "We try to get people into the idea that it's ok to pay the same amount for something that has been reused; it's better because you are doing the right thing."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Furniture that is still in good condition will be sold "as-is" within the Chicago area. If the furniture requires additional work, it will be repaired via the "Rework" program through painting, reupholstering, or by replacing small components.	The "Regroup" line, which covers both reconditioning and remanufacturing revolves around taking old cubicle and benching systems and upgrading and modernizing them to be used in new office settings. Remanufacturing activities are much less developed and most of the time furniture is refurbished, such as taking certain major parts and replacing them as well as refinishing surfaces. The Regroup line also comes with a warranty and installation services.		Currently recycling is being done on a basic level, where materials are directly sent to the scrap yard for disposition.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Rework is using technologies such as upgrading their website and SEO (Search Engine Optimization) to get out the word about the company. Company ambassadors are reaching out to new potential customers and are inviting them to visit the facility to become inspired by the business model.
- Rework has developed extensive partnerships with other companies and competitors nationwide to supply them with reused furniture.
- Rework collaborates with the Chicago community by donating free furniture to the area.
- Special part list brochures and AutoCAD drawings have been developed to make it easier for customers to design and price their own furniture configurations.

Challenges:

- The biggest challenge is pricing for Rework. Overall value of used furniture has decreased in the market. Incentives for customers to do business with Rework regarding recovery of furniture have changed. In the past, Rework was able to pay the customers for their furniture, but now most often Rework has to charge the customers to remove the furniture.
- Requests for more modern designs have been increasing over time. Old cubicle systems and much of the recovered furniture has many components and parts; however the new trend is to have a simple tabletop for office systems. This conversion process from old systems to new is challenging for the company as well as competing with the brand new modern furniture that is on the market.

Next Steps:

- In the future Rework is moving towards getting more creative and finding new innovative ways to update their furniture lines and product portfolio for their customers.

4.4.1 Office Furniture Sector Findings

Recovery Loops

All of the companies in the Office Furniture sector participate in all of the recovery loops. The main focus of the recovery activities is to repair, maintain, refurbish and find innovative ways to reuse furniture. Both Ahrend and Gispen have a good handle on what products that they have manufactured have been sold and are on the market, but are unsure when and how large of a volume will return. Rework does not apply in this situation, as they do not have a fully developed manufacturing system for their own line of furniture; however, they do have the Regroup brand, which are reconfigured and remanufactured cubicle systems. Most materials that need to be recycled are either sent to a scrap yard for raw material separation, or to specific third-party recyclers. One main goal for Gispen and Ahrend is to find new partners in the supply chain that can find a new use for recycled materials to avoid downcycling.

Factors that Enable SVC

Ahrend has a special leasing program Ahrend Reuse, and Gispen also leases furniture and has maintenance and repair as part of the initial contracts. Both Ahrend and Gispen are looking at upgrading their IT infrastructure in the future to optimize their circular systems. Ahrend and Rework have employees who take on leadership roles and are ambassadors who spread the word both inside and outside of the company about sustainability and the benefits of furniture reuse. Partnerships and collaboration are also important in this sector whether it is through collaborations with the community, the government, or with other research organizations. Collaborating with multiple companies and competitors nationwide is also important for Rework to establish networks for furniture reuse opportunities.

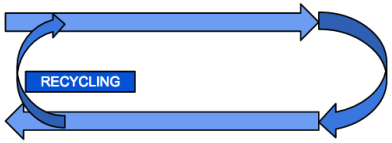
Additional Findings

Pricing in the market for raw materials is a common challenge for this sector. Furthermore, for Rework the pricing for new furniture competes with their ability to sell the used furniture to the market. All of the companies are also trying to overcome the public misconception that refurbished or used furniture is somehow second-rate or of lesser quality. The companies are trying to change the mindset of their customers to show them the benefit of reusing furniture as well as the positive aspects of leasing programs.

4.5 Case Study Group Five – Material Handling/Packaging

MONOFLO INTERNATIONAL, INC.

Location: Virginia, USA (HQ), North America
Number of employees: Approx. 250
Founded: 1973
Products/Services: Returnable Packaging and Injection-Molded Plastic Products



Monoflo participates in the recycling loop only.

Sustainability Reports or Documents: N/A
Initiatives or Partnerships: Part of MHI Association (Material handling trade association)
Certificates or Certifications: N/A

Quote: "Returnable Packaging contributes to sustainability within the sector as it helps to avoid use of wood or paper products that are not reusable."

REPAIR X	***RECONDITIONING X***	***REMANUFACTURING X***	***RECYCLING ✔***
Monoflo does not perform any services relating to maintenance for their products. The reason is that the cost of labor to repair them would be higher than value of the products themselves.			Monoflo has been buying back their own products as well as competitor products that have reached EOL for recycling purposes for over 12 years now. (Approximately 8.8 million pounds a year recovered, with a goal for this year of 12 million pounds.) The recovered plastic is re-pelletized and re-used to make recycled containers.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- The sales group communicates with the customers to convince them to return their materials for recycling.
- The owner is always thinking of how the company can be more sustainable and continually works on new and innovative ways to push the company in this direction.
- Monoflo is a lean organization and also tries to invest in technologies and focus on designs that enable a longer lifecycle for their products.
- Monoflo continually improves their internal operations by implementing internal recycling systems for water and investing in high efficiency electric presses.

Challenges:

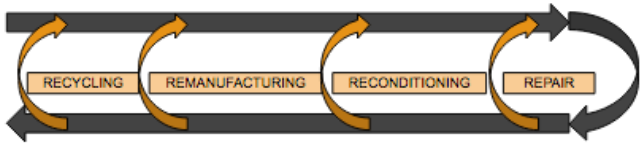
- Initial investments for recycling facilities and operations are very costly. Also, costs of raw materials have come very close to price of recycled materials in the market.
- Long distances in North America make it difficult to operate the recycling facilities due to the customer shipping or pick–up point for recovered materials.
- Multiple colors of returned plastic material make it difficult for recycling, as the processed plastic will always turn out gray or black after the recycling process. If a customer requires a specific color it is not possible to use recycled material.
- In USA many containers for packaging are not a pooled resource, and this makes it more difficult for companies and sectors to collaborate in regard to packaging fleets.
- Monoflo can only take back products when they know the full composition of the materials. Virgin material is added to ensure high quality levels for recycled products.
- Most customers end up discarding their damaged or unusable packaging, as they are unaware of what options are out there for recycling and recovery.

Next Steps:

- Information about sustainability and the recycling efforts are only partially communicated throughout the organizational levels at Monoflo. The future goal is to improve in this area and get more team members involved.
- In addition, the company has a moving-target of increasing their recycling levels as capacity increases.

VANDERLANDE

Location: Netherlands (HQ), Global
Number of employees: Approx. 4,000
Founded: 1949?
Products/Services: Baggage, Conveyor and Material Handling Systems



Vanderlande participates in all recovery loops. Main focus is on repair and reuse.

Sustainability Reports or Documents: Sustainability Report 2015, Annual Report 2015
Initiatives or Partnerships: Netherlands Circular Hotspot, C2C-Centre
Certificates or Certifications: C2C Blueveyor Conveyor systems

Quote: "Our mission is to improve the business of our customers constantly. We are the core business of our customers."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Reuse and repair of small motor parts are carried out. Spare parts warehouse has recovered products that can be used to build new products, or for service purposes.		Vanderlande is in the start-up phase of developing a new partnership for remanufacturing with SEW Eurodrive for electro motor drives.	Collaboration on product design for recyclability is being done with a tub manufacturer as well as with waste company Suez. Also the company is partnering with waste companies in regard to reverse logistics development.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Each department in the company has special Ambassadors or sustainability leaders that work on specific goals and initiatives.
- Product design is an important aspect for Vanderlande and they talk with customers and including them on product design considerations. Design for their end customer in mind is critical, as they need to include the operator as many designs are for man-machine interfaces.
- Vanderlande has developed a C2C conveyor system called "Blueveyor." This system consists of materials that can be reused for new conveyor systems at the EOL due to their design considerations for disassembly and re-usability. In addition, they are 99% recyclable and fewer components and materials lead to energy savings.
- Vanderlande has also created a reverse logistic warehouse for taking products back and also deals with life-cycle services as one of their main business activities.

Challenges:

- Internationalization has led to the development of more business outside of Europe such as in the Middle-East markets. One specific challenge involves understanding how to adapt to new global situations. Knowledge about the circular economy can vary between different regions, in addition to the drivers for business being mainly for risk reduction versus being driven by sustainability.
- Since 50% of the business at Vanderlande is in procurement, influencing the supplier chain can be a difficult task. Getting information about product composition can be a problem at the lower levels of the chain due to a lack of information resulting from intellectual property rights.
- Managing the spare parts warehouse can be challenging, as there can be high uncertainty in inventory levels unlike new material stock. In addition, the actual costs of physically returning or recovering materials back to Vanderlande can be a barrier.

Next Steps:

- Sustainability is in the budget of each of the company's departments; they take initiative and push through sustainability initiatives through the levels.
- Vanderlande is now re-evaluating and making some changes at the department level. Plans are being made that will be presented to the board about how each department will play a role, and what costs and benefits are involved.

4.5.1 Material Handling/Packaging Sector Findings

Recovery Loops

The types of recovery loops that each of these companies address differ greatly due to the differing business models and type of product that they manufacture or provide. In this case Monoflo is a producer of returnable packaging such as plastic containers, tubs and pallets. On the other hand, Vanderlande's business mostly includes procurement of material handling and packaging similar to the tubs that Monoflo provides. Vanderlande is actively working with companies like ones similar to Monoflo on collaborating on improving product design for recyclability. This in turn matches up with the business model of Monoflo, who mainly participates in recycling of their products for the manufacture of new products.

Factors that Enable SVC

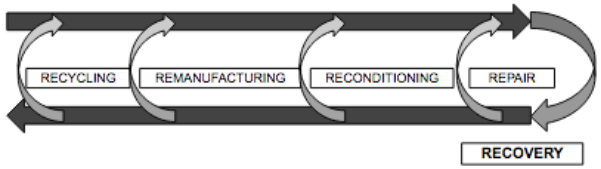
The factors that enable SVC also vary between the two companies. For Vanderlande, product design is important, which is reflected in their development of the Cradle-to-Cradle (C2C) Blueveyor system that allows for more efficient disassembly and reusability of components. Furthermore, designing products with the end-user in mind is always critical for Vanderlande. For Monoflo, the sales team takes a proactive role in telling their customers about the benefits of returning their products for recycling. Monoflo is also a lean organization and benefits from a strong leader and CEO who is always thinking about how to integrate sustainability into the organization.

Additional Findings

For both companies, similar challenges can be seen in regard to reverse logistics and bringing products back for recovery especially in regard to the costs involved. Since Monoflo operates within the entire North American region, the location of their facilities for recycling are critical to ensure that logistics and transport are feasible and cost-effective for customers to return the containers. Furthermore, Monoflo is addressing challenges in regard to the quality of returned materials due to the fact that there is no official regulation on the plastic composition; and thus, they have to mix the recycled materials with virgin plastic. For Vanderlande, the internationalization of their company comes with new challenges that include understanding and learning how to adapt to new environments and differing viewpoints on the circular economy. In addition to this, Vanderlande is working to influence the entire supply chain to ensure that suppliers are addressing the circularity of their products, such as through new collaborations in regard to remanufacturing activities.

4.6 Case Study Group Six - Startups

Location: Netherlands (HQ), Global Projects
Number of employees: Approx. 33
Founded: 2014
Products/Services: Deep Sea Cable Recovery Services



CRS Holland does not directly participate in the four loop activities, but helps to enable these activities through the recovery process itself.

Sustainability Reports or Documents: N/A
Initiatives or Partnerships: Partnerships with Circle Economy & MVO Nederland
Certificates or Certifications: ISM Code, Pursuing ISO 9001 and 14001 for Office

Quote: "To create value by leaving the world in the same way or better than when you came in and at least not worse, that's what I believe in. I also believe that you need to be able to sustain yourself without subsidizing to do this."

REPAIR	***RECONDITIONING***	***REMANUFACTURING***	***RECYCLING***

The main business model of CRS Holland is cable recovery with 20,000 km of cable recovered so far. Overall, 94% of cables are being left on the seabed by the telecom companies (telcos), 2% are upgraded, less than 0.6% is reused, and only 3% recycled. There are various options for other companies such as reusing shorter cable lengths between a main country and a nearby island, or by recycling the cable materials, which include aluminum, copper, steel, and plastics, for use in various sectors and products.

Sustainable Value Creation - Tools, Methods, and Strategies:

- Outreach to the public is important in order to develop interest in what the company is doing and what is happening in the telecom industry with the cables.
- CRS Holland aims to convince the telcos to sit down with their cable suppliers to make changes regarding product design to improve recyclability and disassembly.
- CRS Holland has an agreement with the Dutch government to permanently store the repeater components from recovered cables, as they contain radioactive waste.
- The culture is very important for CRS Holland and everything they accomplish together is through teamwork.

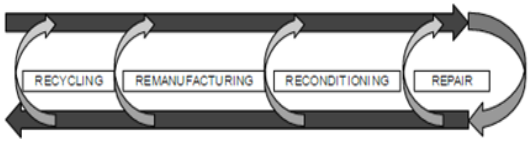
Challenges:

- The biggest challenge is to change the mindset of the telcos. They are not currently thinking about circular systems; however, things seem to be catching on. It is also hard for CRS Holland to convince them to allow CRS to remove the cables.
- Challenges exist for LDPE and HDPE plastics that are materials that are within the cables. The goal is to find new product streams for these materials such as in the food industry. However, this industry does not currently have a standard for recycled plastics. At this time they only accept virgin materials, as the tests are very strict.
- Technology in terms of the cable capacity moves very fast and new cable systems are continually being laid on the seafloor. The telcos leave the old cable systems, as they believe it does not have a significant environmental impact. Furthermore, new cables are placed on top of old ones, which can complicate the recovery process.

Next Steps:

- CRS Holland a big goal of increasing the recovery for reuse or recycling up to 100% in the future. To meet this target CRS Holland wants to take the next steps: first, continue to grow and add more vessels to the fleet; second, increase the portfolio of cables in multiple locations worldwide; and finally, implement a big data system on the vessels that will give CRS Holland important information about the vessel, such as fuel consumption, and the recovery processes.

Location: Netherlands (HQ), Local
Number of employees: Approx. 4 people
Founded: 2015
Products/Services: Consumer Electronics - Headphone Repair and Maintenance Leasing Service



Gerrard Street participates in all recovery loops. All recovery activities and processes are outsourced except for finding clients and headphone design.

Sustainability Reports or Documents: N/A
Initiatives or Partnerships: Climate-KIC Start-Ups
Certificates or Certifications: N/A

Quote: "I think that sustainability it is the same as sound quality. It is an integral part of the company. Every company should see it this way: companies should not only produce something and afterwards try to make it more sustainable. You should start with the sustainable perspective and build from that."

REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Repair and Reconditioning activities are done in the Netherlands where modules within the headphones are replaced with new ones. The old modules are then reused for new headphone sets as needed.		Remanufacturing is outsourced and currently being carried out in China.	Most of the components such as the metal and plastics can be recycled, but the leather and cables are for future recycling consideration. This loop will be more applicable in the future, as the headphones that are currently out in the system have not yet come back.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

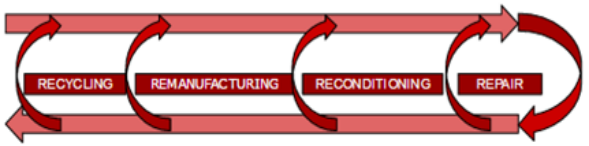
- Headphones are good quality and provide value for the customer. This is reflected in the headphone framework (frame and speakers) as they can last up to 10 years.
- With the offer of quality headphones comes a repair and maintenance program that enables recovery of the product in a circular way.
- Having a customer focus and innovating to solve customer needs is most important. The company tries to address specific needs, such as headphones breaking easily, with their business model.

Challenges:

- Funding and clients are the biggest challenge. Getting a subscription based model more readily accepted by new clients as well as getting the required funding needed to scale up the company can be complicated. Clients provide funding, however, the company needs to scale to find clients. This creates a "chicken-and-egg" situation.
- Recycling and overall circular processes can be challenging due to the costs involved. The company is now at 60% circularity with their products and wants to improve this in the future. Costs of returns are also a challenge when the cables being returned cost more to ship than they are worth.
- Challenges are not in the technical aspects but in the market for Gerrard Street. The company is facing the mindset in the market that if a product is sustainable it is somehow inferior in terms of sound quality or design. They hope to overcome this by providing a quality product that is not only sustainable, but can be bought at the same price as any other headphone product.

Next Steps:

- The company plans to continue to scale and expand their position in the market. Gerrard Street's vision is to scale up first in the market in order to reach their goal of 100% circularity.

Bundles We love laundry ***Location***: Netherlands (HQ), Local ***Number of employees***: Approx. 4 ***Founded***: 2015 ***Products/Services***: Washing Machine Lease and Laundry Subscription			Bundles participates in the Repair loop and will address the other three loops in the future.
Sustainability Reports or Documents: N/A ***Initiatives or Partnerships:*** Partnerships with Stichting Doen, Miele, Circle Economy, Ellen MacArthur Foundation ***Certificates or Certifications:*** N/A		**Quote: "**Our overall view of sustainability is that we think that the values should be kept in the materials and the products that are developed and should be designed in a way that aims to maximize that value for a long time."	
REPAIR ✔	***RECONDITIONING ✔***	***REMANUFACTURING ✔***	***RECYCLING ✔***
Repair is done by Monteur op Afstand (workers at a distance) and through service contracts with Miele. Logistics for recovery is handled through an outside partnership.	Reconditioning will come in the future, approximately 8 years after installation, when washing machines begin to break down.	When the product comes closer to EOL, around the same time as the reconditioning activities, considerations for an entire remanufacturing program and facility location will need to be addressed.	Recycling is a future consideration after all of the other recovery loops are no longer feasible. Bundles wants to avoid recycling due to negative environmental effects.

Tools, Methods, and Strategies that Enable Sustainable Value Creation:

- Bundles works very closely together with Miele, the main supplier of the washing machines.
- Since it is a contract-based maintenance system, costs and risks are reduced for the customer. Clients are also coached in maintenance to help with upkeep and are taught best methods of washing.
- Technologies like Skype and FaceTime are utilized by Monteur op Afstand (worker at a distance) to help to enable maintenance and small repairs remotely. In addition, appliances are connected to the internet via the Wash-App and Bundles Buddy router to gather data to give information and advice to customers about their usage.
- Sustainability and the Circular Economy are the main reasons for the existence of the company and are reflected in their business model of pay-per-use.
- The clients are active ambassadors promoting Bundles in the community.

Challenges:

- The biggest challenge for the company is to convince society to move away from the idea of ownership and move towards consuming in a circular way.
- A future challenge may be developing a system for remanufacturing as the company feels that some manufacturers do not see value in remanufacturing.

Next Steps:

- Bundles is looking for ways to make the appliances more upgradable or more easily remanufactured by convincing the appliance suppliers to help in this process.
- The company would like to apply their current business model to other products in the future such as other electrical household appliances.
- In the future the main next steps include: upgrading and developing the software systems, connecting multiple appliances throughout many countries, and finally utilizing the gathered data from appliances in a way that enables better usage and future product design.

4.6.1 Startups Sector Findings

Recovery Loops

Both Gerrard Street and Bundles are participating in all four recovery loops to a certain degree. Since both of these companies just launched within the past two years, the recovery loops are currently not as highly developed. For example, some of the loops that Bundles is looking to participate in, such as remanufacturing or recycling, will not be encountered until the products have reached their EOL. Gerrard Street and Bundles both take advantage of a product-service systems and leasing contract for their products. For CRS Holland, their primary purpose is to physically recover the cable materials and they do not directly participate in the four recovery loops. They enable other companies to take advantage of reusing the recovered materials in new ways such as for recycling or for reuse in new cable networks.

Factors that Enable SVC

Technology, such as monitoring systems and wireless applications are key for companies like Bundles to provide circular products and services. Furthermore, collaborations with their suppliers such as Miele are critical to ensure the longest life-span of the product. For Gerrard Street, it is also important that products provide not only value in terms of sustainability but also value through the offering of high quality products. For CRS Holland, agreements with the Dutch government, as well as their internal teamwork within the organization are critical to the operations of their business and the goal of recovering as much cable as possible from the ocean floor.

Additional Findings

The biggest challenge for Bundles and Gerrard Street is to convince society and the consumers to adopt a service-based lifestyle that prioritizes access over ownership. CRS Holland is encountering similar challenges in convincing the telcos to keep circularity in mind for both the way the materials go into the production of the product, as well as how they lay the networks to account for ease of removal. Gerrard Street wants to continue to scale up and find new clients in order to further develop their businesses as well as to help to overcome costs that are affecting the feasibility of repair and reconditioning. Furthermore, financial considerations including funding were aspects that were mentioned by Gerrard Street as being critically important for startups to be able to provide these new business models. In the future both Bundles and CRS Holland want to upgrade their technology and IT systems to optimize their recovery processes and services, as well as improve the design of future products.

5 Results

5.1 Factor Interaction

Results from coding the interview responses have given an indication of which specific factors that enable SVC interacted with each other. These interactions are important to note as they show that these factors (tools, methods, and strategies) are not always utilized alone, but that they play an important role together for enabling SVC.

Most of the specific factors were covered in the questionnaire, so the factors treated in this section were determined only by the fact that companies mentioned these factors themselves during the generalized interview questions. Thus, the treatment of factors here does not represent an even distribution from all companies, and was dependent on which company gave the most information that referenced specific factors. It should only be used as a guide to understand which factors interact together, not as a specific ranking or a way to score the importance of the factors. Figure 9 below gives an overview of which types of factors were mentioned in the 11 general interview questions. The arrows between each factor and the factor categories represent which types of interactions exist according to the interviews. Appendix 5, Table 13 provides details on the exact interactions between the different factor categories as well as the descriptions of each factor.

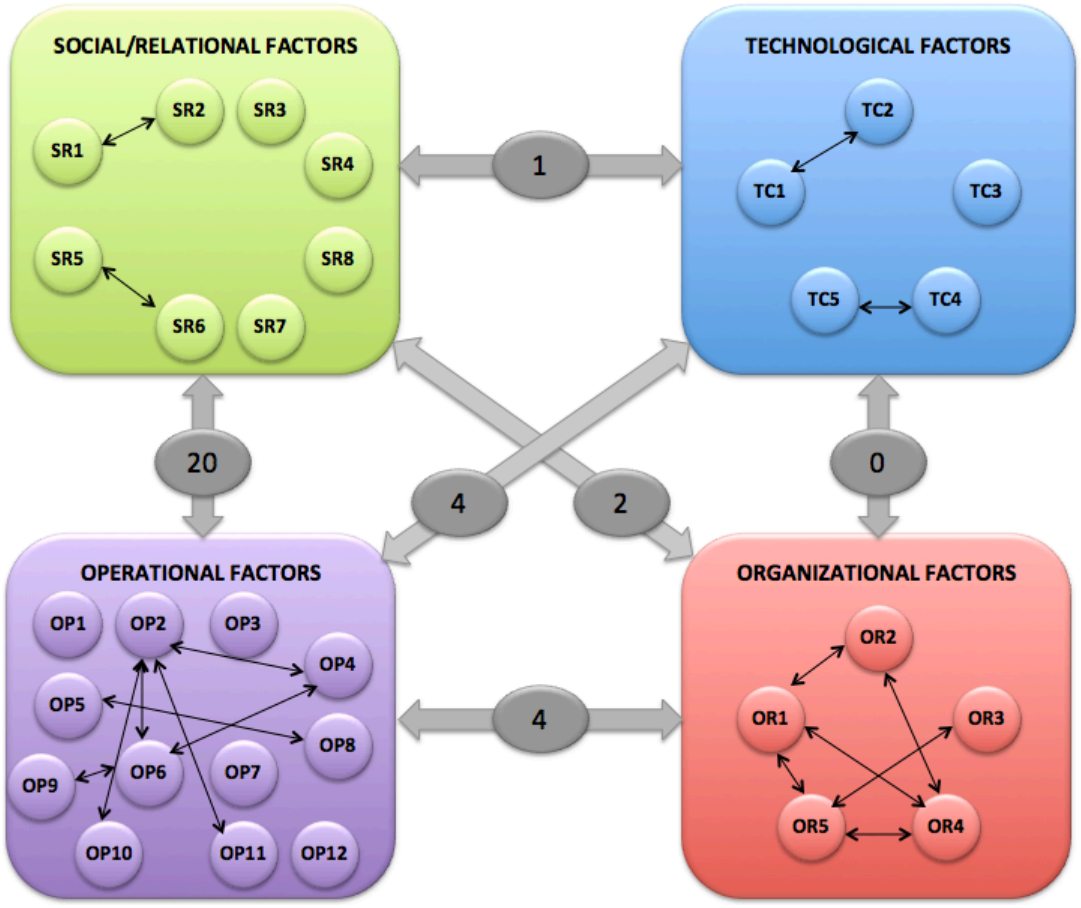


Figure 9. Factor Interactions from Coding of Interview Responses

The figure above shows the high level of interaction between specific factors within specific groups. For example, the highest level of interaction within the factor categories was found in the Operational (hereafter OP) and Organizational (hereafter OR) categories. For example, the most often mentioned interaction between OP factors was between OP4 (Product Design Considerations) and OP6 (Product Life-Cycle Management). This relates back to the case studies where the companies mentioned that when designing products it is important to account for the entire life-cycle of the product, such as designing for EOL considerations like disassembly or recyclability. Furthermore, many companies make use of Life Cycle Assessments (LCAs) to determine the impacts of different design or materials choices. The OR interaction between OR1 (Organizational Alignment) and OR5 (Company Culture/Philosophy) was also mentioned multiple times. Some of the companies are trying to integrate sustainability within every position and level within the organization. This is reflected in the statements made by the interviewees in the case study such as the use of CSR or sustainability ambassadors in different departments. For the category interactions, the highest number of interactions occurred between the Social/Relational (hereafter SR) factor category and the OP factor category. Some examples of these interactions include: developing partnerships for reverse logistics and recycling, collaborating with customers of product design, or collaborating with suppliers on materials and improving circularity. Finally, the Technological (hereafter TC) factor category had one of the lowest rates of interactions within the category as well as the lowest interactions between other categories. Although technology was mentioned quite often in the case studies as being important, most companies mentioned it as an issue they would address in the future.

5.2 Factor Questionnaire Results

This sub-chapter gives a graphical overview of the responses that were given from each company in regard to the factor questionnaire. This secondary form of data, after the general interview questions was helpful in analyzing specific factors as determined from the literature. Each interviewee was asked to rank individual factors for the questionnaire. Factors were given a ranking on a scale from 1 to 10, with 1 being of lowest and 10 being of highest importance to enabling SVC in their recovery loops. When a factor was noted as being “not-applicable” it was given the score of 0. This is to ensure that these factors are counted and given a numerical value. Table 16 in Appendix 8 shows when factors were not applicable (given a score of 0). As a note, although some factors ranked quite low, either by the application of low rankings or a high number of N/A responses, it is not to say that they are not seen as important in the long-term. Interviewees mentioned that even though they considered certain factors being N/A, they might be of importance in the future. Finally, this questionnaire was completed with the caveat that the rankings given by each interviewee were related to their current state of business activities.

5.2.1 All Factors

Figure 10 below compares all 30 factors and gives them an average score/ranking based on the responses from the 16 companies. The factors are arranged from highest score, in the top left side, to the lowest score in the bottom right side. Above each specific factor name is the corresponding code designation (E.g., OP3 for Labeling). No factor was found to have scored lower than a 3.8, and the highest score recorded was 9.2. These results show a large range of variability regarding which factors the companies thought contributed to SVC.

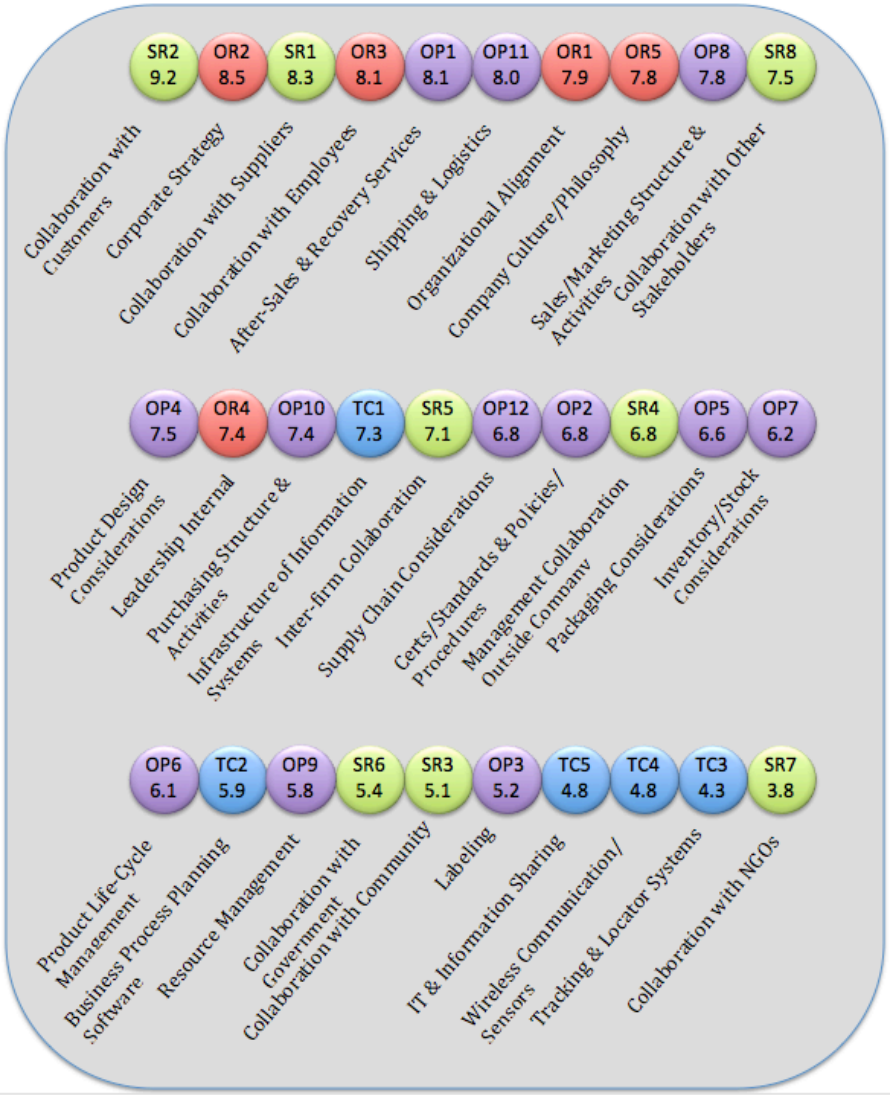


Figure 10. All Factor Rankings

From the figure, it can be noted that overall, the TC factors ranked lowest, and the SR factors ranked the highest. The OP factors fell mostly in the middle of the rankings. Both the OP and SR Categories had the highest amount of variability. From all of the companies interviewed it can be seen that the SR factor of Collaboration with Customers ranked highest, and the SR factor of Collaboration with NGOs ranked lowest. It is interesting to see

that one factor category (Social/Relational) resulted both in the highest and lowest overall ranking. These findings are comparable to the results from the case studies where customers were mentioned in various aspects such as customers participating in the product design phase as well as companies working with customers to train them on service related maintenance programs. Furthermore, the results of the NGOs ranking the lowest corresponds to the findings from the applicability analysis where the factor relating to NGOs was most often market as N/A in the questionnaire.

5.2.2 Factor Rankings per Category

Social/ Relational

The highest ranked factor within the SR category was SR2 (Relationships with Customers) followed closely by SR1 (Relationships with Suppliers) as shown in Figure 11 below. This was reflected in most of the companies stating that the customer was the number one priority and without the buy-in from the customer, the various business models would not be successful. The lowest ranking factors included SR3 (Collaboration with the Community) and SR7 (Collaboration with NGOs). Many companies had only limited relationships with the community or NGOs. There were a few that had specific partnerships such as Interface with the Zoological Society of London, or Rework By ROE with the Chicago community. Although almost all of the companies were noted as having some sort of collaboration with organizations, especially with MVO Nederland or the Netherlands Circular Hotspot, in the end the companies determined that these categories were not the most important when enabling sustainable value creation. This category of factors had the highest amount of variability from the lowest being at 3.8, to the highest at 9.2.

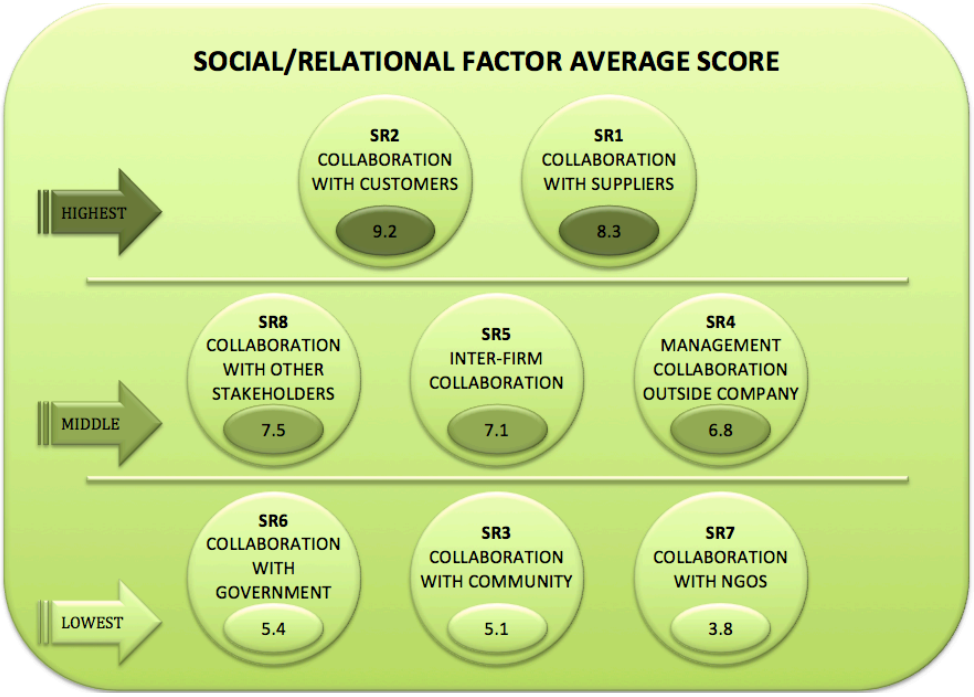


Figure 11. Social/Relational (SR) Factor Rankings

Technological

The highest ranking for TC Category was TC1 (Infrastructure of Information Systems) for companies as reflected in Figure 12 below. The lowest ranked factors included TC3 (Tracking & Locator Systems), TC4 (Wireless Communication/Sensors), and TC5 (IT & Information Sharing). Overall the factors ranked from a score of 4.3 to 7.3. This category showed the lowest overall scores for the different factor categories. Factor TC1 (Infrastructure of Information Systems) was ranked as the most important factor, which is reflected in the findings of the case studies, where the overall infrastructure of the IT systems was important to enable reverse logistics and manage warehousing and inventory for spare parts. TC3 (Tracking and Locator Systems) and TC4 (Wireless Communication/Sensors) were ranked lowest, but this was an unusual result as there were many examples given in the case studies that these technologies were being utilized. The main companies that mentioned tracking or monitoring systems were Caterpillar and their diagnostics and indicators on their tractors, Bundles and the wireless and internet-based systems for the washing machines, and Mitsubishi Electric with the new monitoring systems they are integrating into their elevator systems. Furthermore, many companies mentioned that it was a critical next step to address information and technology systems. Another finding showed a mixed response about IT and information sharing where most companies stated during the questionnaire that internal sharing of information was beneficial, but sharing information on the outside was not possible due to reasons such as competition and possible intellectual property concerns.

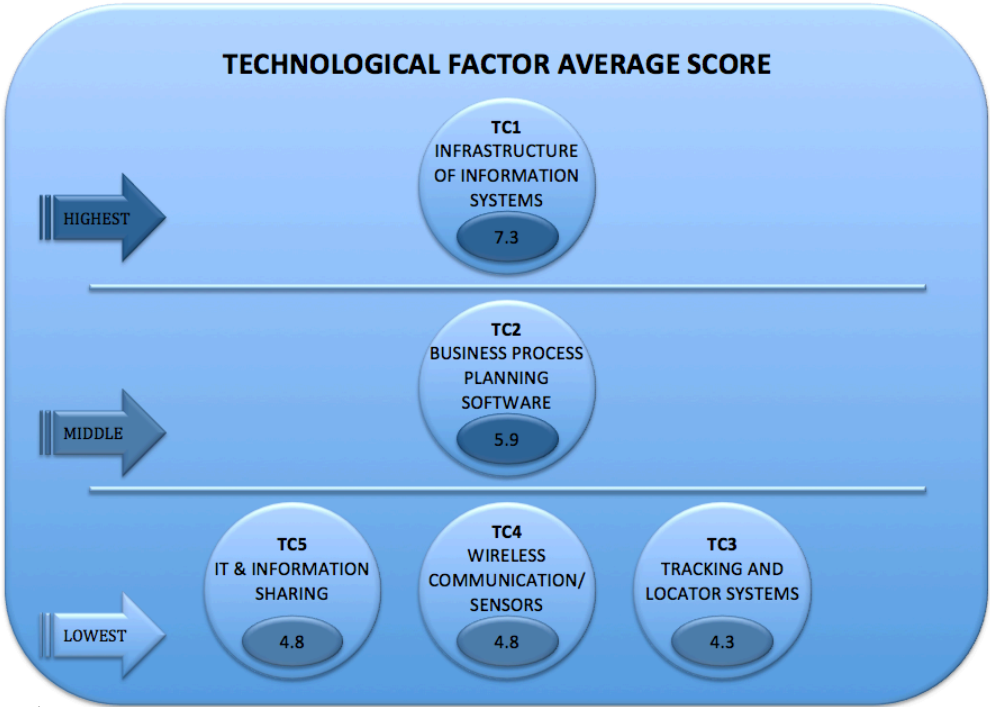


Figure 12. Technological (TC) Factor Rankings

Operational

Highest ranked factors for the OP category were OP1 (After-Sales and Recovery Services), OP11 (Shipping and Logistics), and OP8 (Sales/Marketing Structure and Activities). Least important factors include OP3 (Labeling), and OP9 (Resource Management) according to Figure 13 below. Most factors were ranked at 5 or above, signifying that they are all of medium to high importance for enabling SVC. For the OP1 factor, many companies have special contracts such as pay-per-use or leasing models and for some of the startups such as Gerrard Street and Bundles said it is the reason why they are in existence. OP11 is the next highest ranked and is seen in the case studies by the importance placed on reverse logistics and transportation in general. In addition, according to the companies it is very hard to set up the logistical infrastructure and this can be very costly especially for companies such as Monoflo who recover their products for recycling all across North America. OP8 also ranked in the higher level since sales and marketing works along with the after-sales contracts and leasing systems and this department is the one that facilitates those agreements. OP4 (Product Design Considerations) was also mentioned by almost all of the companies because the product design affects how easily a product can be recycled or disassembled into components. Specifically ACE Wikkeltechniek and Ricoh mentioned the importance of designing products for disassembly for remanufacturing. Factors that involved purchasing, certifications, supply chain, packaging, inventory, and product life cycle management were ranked in the middle of the factors. OP3 (Labeling) and OP9 (Resource Management) scored the lowest and many companies explained that labeling was either not applicable or did not have a function in regard to enabling the recovery of the product. Often the companies stated that the labeling could be viewed as more tool for marketing, but not for enabling SVC.

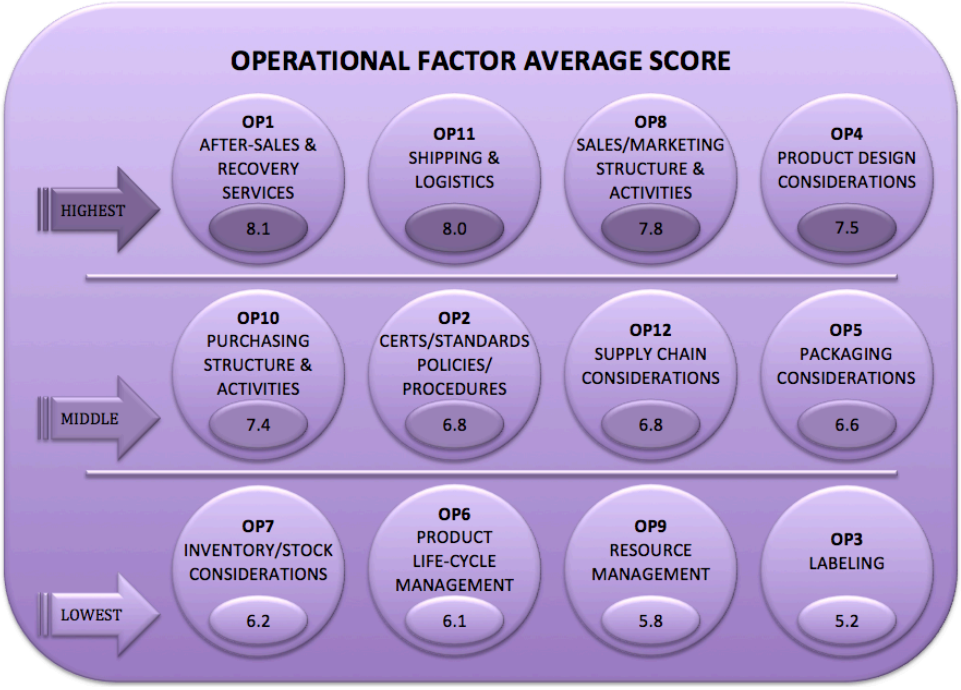


Figure 13. Operational (OP) Factor Rankings

Organizational

The highest ranked OR factors include OR2 (Corporate Strategy) and OR3 (Collaboration with Employees) as reflected in Figure 14 below. Remaining factors of OR1 (Organizational Alignment), OR5 (Company Culture/Philosophy), and OR4 (Leadership Internal) were least important, however, no large difference exists between the top and bottom categories and all factors were ranked significantly high. Factor OR2 ranked highest and is reflected in the statements of the companies in the case studies where they stated that circular thinking or sustainability needed to be integrated within the strategy and sustainability goals. For example, Canon has a group that meets on a quarterly basis to discuss the company's Circular Economy goal and related initiatives. Furthermore, the strategy as well as the company philosophy is clearly defined in the business models of Interface, where they want to move from being a restorative company to a regenerative company; CRS Holland, who has developed a business based specifically on recovery; and finally, Thermaflex, who has been certified as a B-Corp in Northwest Europe. Additionally, OR3 such as collaboration and teamwork with employees across many departments and functions was mentioned. For example, Gispen explained how important the employees were for carrying out the methods and tools for sustainable value creation and stated that without the full support of the employees, the specific tools and strategies would not be successful. Furthermore, Gispen explained that employees must be credited and recognized for their achievements. Finally, internal leadership ranked as lowest, which is an interesting finding since many companies such as Ahrend, Bundles, Vanderlande, Monoflo, Rework by ROE, and Philips all talked about the importance and influence of CEOs and other CSR and Sustainability ambassadors within the organizations for enabling SVC.

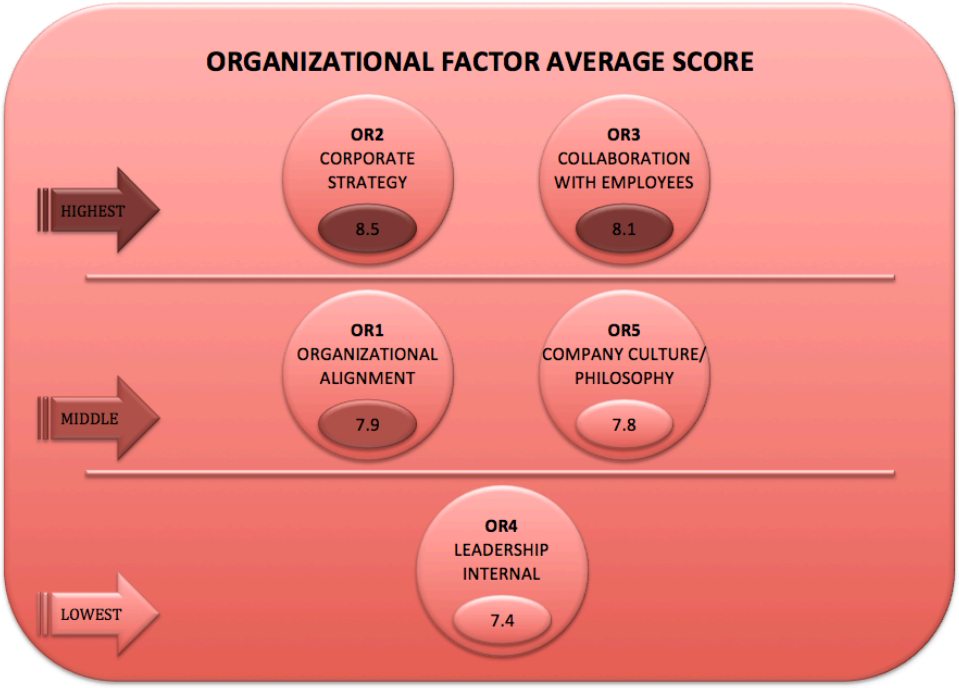


Figure 14. Organizational (OR) Factor Rankings

Factor Category Comparison

Rankings of each factor category have been calculated in Figure 15 below with a cumulative average score for comparison. Overall for all companies and all factors, Organizational factors had the highest score and Technological the lowest. Furthermore, the Operational and Social/Relational categories are almost evenly scored for second highest importance.

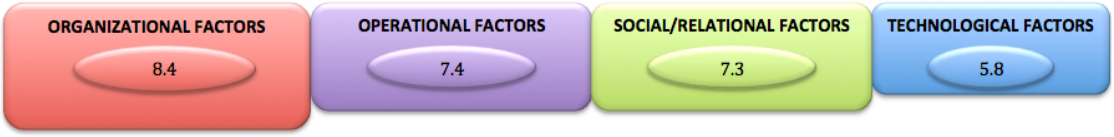


Figure 15. Average Factor Category Ranking

5.2.3 Factor Rankings per Sector

Figure 16 below shows the order from highest to lowest of each of the factor categories ranked within each sector. For example, within the Electronics Sector the highest ranked factor category was OR (Organizational), and the lowest SR (Social/Relational). All factors had almost identical rankings except for Electronics and the Startups sector. Electronics gave a higher ranking to TC (Technological), and the Startups gave a higher ranking to SR (Social/Relational) than the other sectors.

For the Manufacturing/Machinery, Office Furniture, Insulation/Carpet, and Material Handling/Packaging sectors, the factor categories were all ranked in the same order. This is an interesting finding because it shows a similar perspective regarding the factors and in terms of enabling SVC even from sectors that are very different from each other. The Electronics sector and Startups differed from the other sectors in that Electronics sector gave more importance to the Technological factors. This may be due to the fact that the products that the companies produce are electronic or technological in nature. For the startups, Operational factors were ranked lower than all of the other sectors since many startups do not yet have the full infrastructure and development as other companies. This was reflected in the statements made by Gerrard Street that at the current time the overall strategy and development of business model, including getting more clients and scaling up, is more important than some of the structures like expanding on logistics or having a high-tech inventory management system.

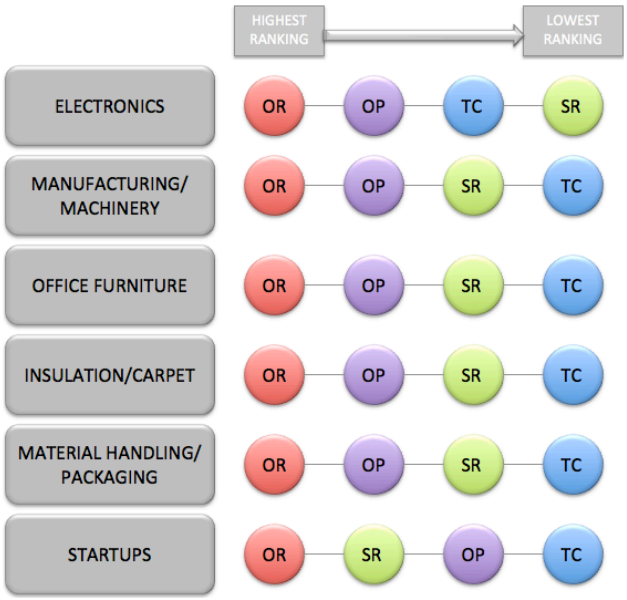


Figure 16. Factor Category Rankings per Sector

The following sections are the summaries of the top three factors for each sector, based on the cumulative average score for each factor.

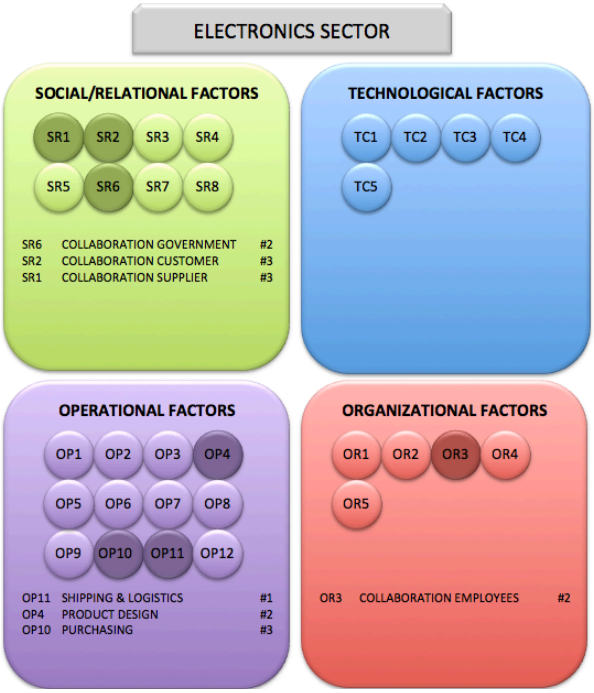


Figure 17. Electronics Sector Results

Electronics Sector

The number one factors for the electronics sector (Fig. 17) were OP11 (Shipping and Logistics), SR6 (Collaboration with the Government), and OR3 (Collaboration with Employees). This is interesting when comparing these results with the case study. Ricoh mentioned the government in the context that legislation put forth by the EU was unclear, but it did not come up as a main factor that enabled SVC for the sector. It seems that the most important factors from the case study included Inter-firm Collaboration, Product Design, and Certifications. Therefore, the second and third ranked factors such as collaboration with the customer and suppliers, and product design were more in line with the main focus of the case studies.

Manufacturing/Machinery Sector

The Manufacturing/Machinery sector (Fig. 18) had SR1 (Collaboration with Suppliers) and OP1 (After-Sales/Recovery Services) ranked as the number one factors. When comparing this to the case studies, the importance of the after-sales and recovery services are reflected in the specific business models of Mitsubishi Electric's pay-per-use and leasing model, as well as Caterpillar's remanufacturing deposit system. Collaboration with suppliers is not as evident in the case study results. The customer is a factor that is much more in the foreground, such Caterpillar collaborating with customers on product design, or ACE Wikkeltechniek working with the customers to meet their remanufacturing needs.

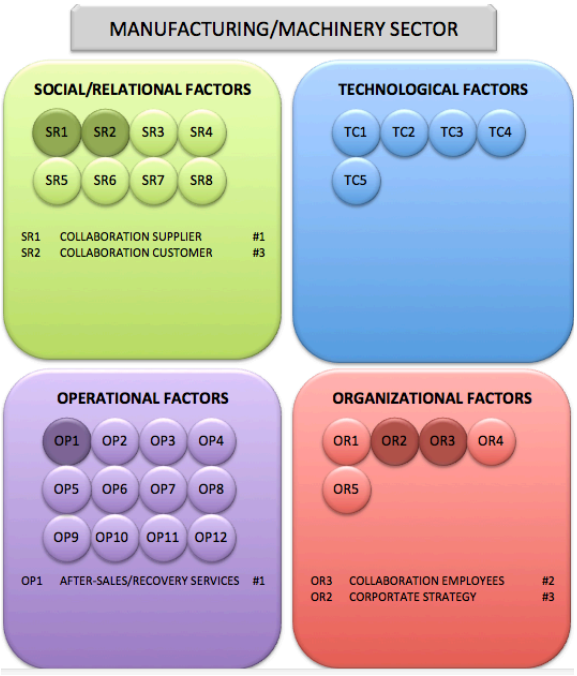


Figure 18. Manufacturing/Machinery Sector Results

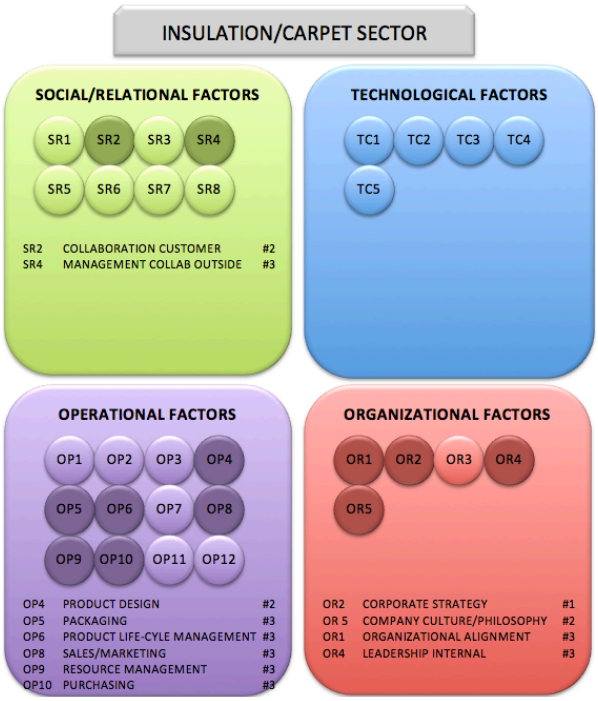


Figure 19. Insulation/Carpet Sector Results

Insulation/Carpet Sector

The number one factor for the Insulation/ Carpet sector (Fig. 19) is OR2 (Corporate Strategy). Also, many factors in the Operational and Organizational categories were found to be important. This finding regarding the overall corporate strategy is in line with the results from the case study in terms of the strategies and goals that Interface has put forth for 2020 and beyond, as well as the strategy and B-Corp status for Thermaflex. These findings are further backed up by the result of OR5 (Company Culture/Philosophy) being one of the most important factors. Also ranked as high were OP4 (Product Design) and SR2 (Collaboration with the Customer).

Office Furniture Sector

The top factor for the office furniture sector (Fig. 20) was SR2 (Collaboration with Customers). The customers are important according to the case studies, especially in regard to securing new clients for the reuse and leasing business models. Furthermore, this sector focuses on the customers, as the companies want to convince them of the benefits of used furniture and change the mindset about reconditioned or refurbished furniture. In addition to this, the case studies focus more on inter-firm partnerships such as Ahrend with the DBFMO projects. Overall, collaboration is most important aspect of the factors for this sector. Specifically, Gispen concentrates on employee retention and empowerment.

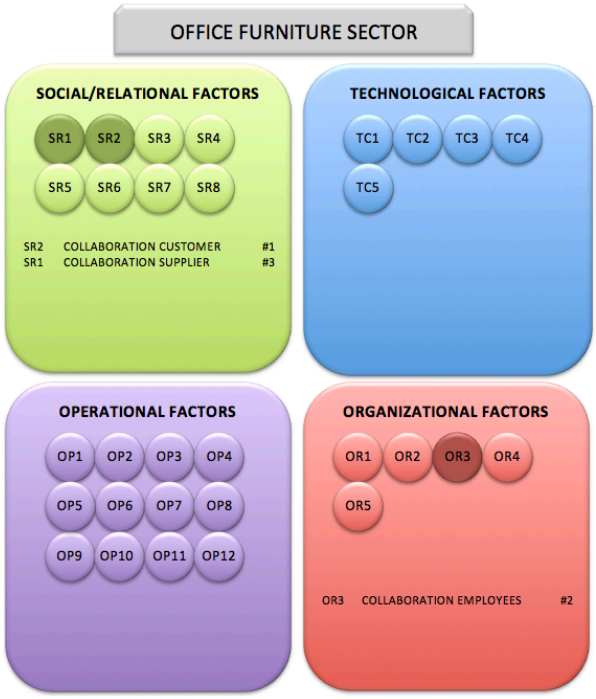


Figure 20. Office Furniture Sector Results

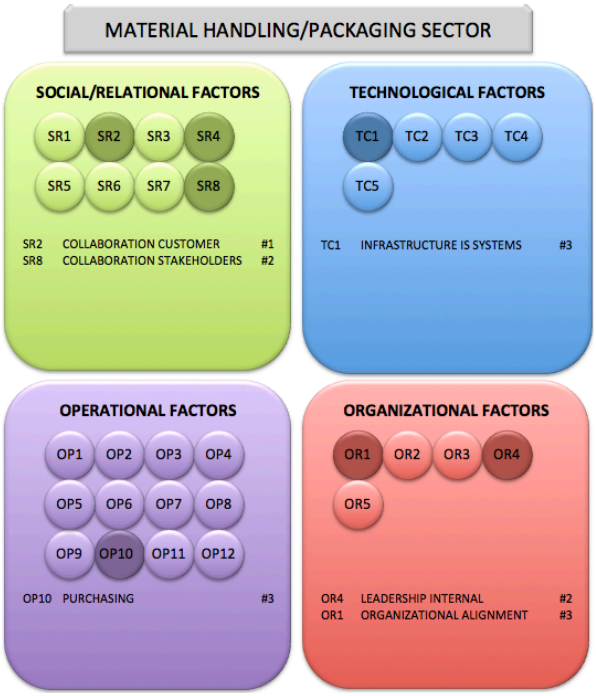


Figure 21. Material Handling/Packaging Sector Results

Material Handling/Packaging Sector

The top factor for this sector (Fig. 21) was SR2 (Collaboration with Customers). This is reflected in the case study results with the comments made by Monoflo where the sales group is working with the customers to convince them to send back their materials for recycling. The recycling of their products is a main part of their business model. Vanderlande also ensure that their customer is kept in mind for product design considerations for the end-user. Purchasing is also factor that is of great importance to Vanderlande since 50% of their business is in procurement. It is also interesting to note that besides the Startups, this sector is the only group to have one of the Technological factors in their top three rankings.

Startups Sector

For the Startups sector (Fig. 22) there were three total factors that ranked as number one in the results. These include SR2 (Collaboration with Customers), OP1 (After-Sales/ Recovery Services), as well as OR2 (Corporate Strategy). This shows that the customer, the business models, as well as the overall company strategy are most important. This is evident in the results from the case studies as the main objective of the startups is to scale up and get more clients who will participate in a product-service-based economy. Finally, this sector also recognized TC1 (Infrastructure of IS systems) as an important factor. This is something that companies like CRS Holland are looking into for the future to further develop their recovery activities.

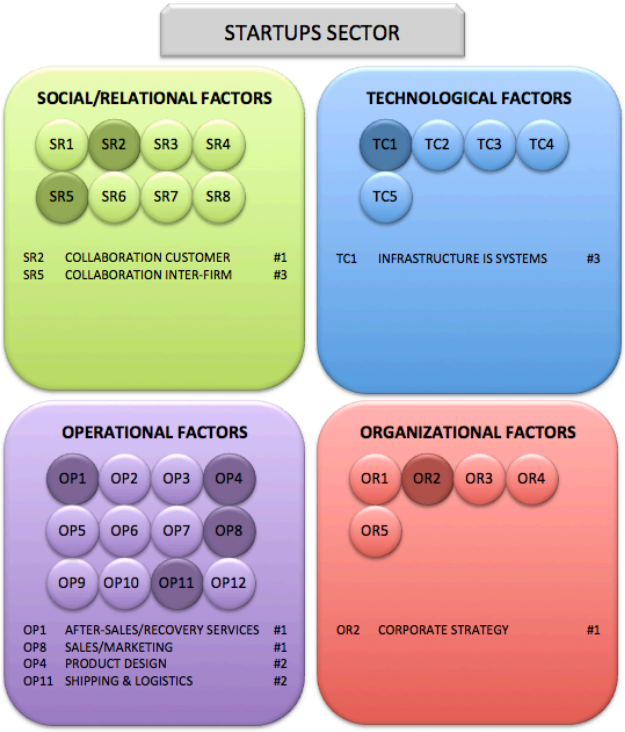


Figure 22. Startups Sector Results

6 Discussion

This chapter aims to relate the findings from Chapters 4 and 5 to the theoretical literature that has been established in this field to determine if there are specific agreements or disagreements that may exist between theory and practice. This information will give insight to researchers as to what is happening in practice, and can help to further promote new research in the areas where there were disagreements in order to determine the causes of the differences. Furthermore, it is important for companies to acknowledge these findings in order to get an understanding of what types of opportunities or strategies they may not be applying which could lead to further SVC.

6.1 Recovery Loops

From the literature it has been stated that the most common form of recovery for companies is recycling (King et al., 2006). The results from the case studies partially support this statement as most companies either recycle within their manufacturing processes, or materials are often given to third party recyclers or sent to a scrap yard for separation. Most often recycling in large volumes is carried out outside of firms due to its prohibitive costs and capital investments, warehousing challenges, and a lack of effort on the part of companies to investigate opportunities for recycling (Difrancesco & Huchzermeier, 2016; King & Lenox, 2002; Simpson, 2010). For example, outside firms such as Van Gansewinkel are stepping in and successfully recycle for other companies, since they are set up for reverse logistics and have an established network for purposes such as recycling (Thierry, 1997, as cited in Fleischmann et al., 1997; Fleischmann et al., 1997). While it is clear from the results that most companies are participating in recycling in one form or another, recycling is not considered the optimal choice for most of the companies. The case study companies consider recycling a lesser form of recovery alternative, and often attribute this recovery loop to “downcycling”, which can result in degradation in material quality (Haas, Krausmann, Wiedenhofer, & Heinz, 2015). Because of the issues with downcycling as well as the removal of responsibility through external recycling, companies such as Philips and Gispen are focusing on how to develop better systems for product stewardship as well as find ways for their waste to be an input for new systems, which is also referred to as industrial symbiosis (Murray et al., 2015). This is in line with the goal of the CE to make wastes a source for new resources (Witjes & Lozano, 2016). Furthermore, the literature supports this step towards product stewardship as it has been stated that there are benefits for the producer to keep ownership of products, including: recovering additional value from the product by adding more service and maintenance schemes, as well as by being able to anticipate any changes in legislation that may affect how they must account for future returns (Mont, 2002).

For remanufacturing, it has been stated by Rashid et al. (2013) that although this recovery loop comes with multiple economic and environmental benefits, very few companies who manufacture their own products are taking advantage of remanufacturing. Furthermore, the theory states that if remanufacturing is actually carried out, it is often by companies in sectors that concentrate on products that are capital intensive, or have a critical function within the end product such as engines (Florin et al., 2015; King et al.,

2006). This can be supported by the findings, where companies such as Caterpillar, who specialize in heavy machinery, have highly developed remanufacturing operations that they been carrying out for over forty years. The study Rashid et al. (2013) also states third party remanufacturers often face challenges with remanufacturing such as dealing with original equipment manufacturers (OEMs) who are lobbying against externally remanufactured products, and therefore the authors feel that the third party remanufacturers are much less likely to be successful. However, the findings of this study show that third party remanufacturers such as ACE Wikkeltechniek are successfully remanufacturing products, due to the fact that they have established collaborative efforts with the customers (OEMs) in regard to improving remanufacturing processes and product designs. In another area of the remanufacturing literature, there have been issues with regard to the definitions of reconditioning and remanufacturing in the scientific community and one study by Ijomah, McMahon, Hammond, and Newman (2007) aims to clear up the confusion. According to the authors, reconditioning involves upgrading components to basic working condition and giving a limited warranty, while remanufacturing involves bringing parts back to original manufacturer specifications and a warranty that is equal to that of a new manufactured part. In practice, companies like Caterpillar, ACE Wikkeltechniek, and Ricoh are also facing similar challenges regarding the language and regulations pertaining to remanufacturing. More specifically, they aim to overcome barriers involved with customs and legislation that do not recognize their remanufactured products as being the same as new. In the case studies, most of the companies stated that they participate in remanufacturing, but according to the definitions supplied by Ijomah et al. (2007) it is not clear that this is always the case. For certain products and sectors that are related to consumer goods a more limited or simple remanufacturing processes may occur and it is unclear whether companies that state that they participate in "remanufacturing" are actually only carrying out "reconditioning" activities.

In regard to repair and reconditioning loops, the theory states that companies should focus on these recovery loops as they require the least amount of energy and are the most profitable (King et al., 2006). The case study findings support this view expressed in the literature, as it can be seen that almost all of the companies participate in these loops. This is due to some extent to the fact that most original product manufacturers already have been recovering products or materials for some time, partly due to product warrantees, recalls, or flow of product returns (Guide, & Van Wassenhove, 2009; Rogers & Tibben-Lembke, 2001; Simpson, 2010). This was confirmed in the case studies where many companies such as Philips, Canon, and Vanderlande are focusing on developing special spare parts programs, or constructing new infrastructure for spare parts warehouses, which often relate to aspects such as product returns. However, companies want to go further than basic repairs for products that are involved in general product returns. The companies have recognized that repair and reconditioning loops need to be further developed, and to address this, the companies are putting extra effort into developing new business models that focus on taking these recovery activities to the next level. Mont (2002) states that business models should move towards a focus on product-service systems (PSS) as these come with multiple benefits. These benefits accrue to both customers and companies. Customers can experience greater variety of choices in the market and access to different repair services, while companies can through these models better ensure product

quality and enjoy overall improved relationships with customers (Mont, 2002). Companies are aware of the importance of PSS and are addressing these points from the literature with the development of new circular business models, where they are trying to "slow the loops," or in other words, keep the products out of the loops for as long as possible (Bocken et al., 2016). For example, Bundles, who just launched their new washing machine lease service, is working with their customers to train them on proper use and maintenance of the appliances. In addition, companies such as Interface also impress upon their customers the importance of continuous carpet cleaning and maintenance to ensure not only a long life for the carpet, but also to make it easier for carpets to be re-used and recycled when they near end-of-life status.

Finally the literature has stated that often times closed-loop supply chains are not always "fully" closed; instead they fall under the category of "partially-closed" or "hybrid" forms of closed-loops where there are different configurations that exist that can lead to added-value for the customers (Wells & Seitz, 2005). This is supported by the case study results where certain companies may participate in all loops even when they are not fully developed in all aspects because they may not have the capabilities or capacity to develop those loops. These types of restrictions then become opportunities for other companies who can perform the recovery services much more efficiently than the main company could internally. Companies like CRS Holland are taking advantage of new circular business models that address this gap by participating in the actual recovery of the materials to enable other companies to reuse them for various purposes. From the results it is clear that these third parties, or partners outside of the chain, are often the main link between the forward supply chain (FSC) and the reverse supply chain (RSC), and according to the literature, this "integration" of the FSC and RSC is critical to enable value creation in CLSCs (Schenkel, Krikke et al., 2015).

6.2 Factors that Enable Sustainable Value Creation

According to the theory, "soft" or people-focused issues, which take into account values, philosophies, and social relationships, are needed for organizations to move towards being more sustainability focused as well as when transitioning to more sustainable supply chains (Burgess, Singh, & Koroglu, 2006; Closs et al., 2011; Lozano, 2012; Muduli, Govindan, Barve, Kannan, & Geng, 2013). More specifically, collaboration was a repeated theme within the literature that stated both internal and external collaborative relationships were necessary to meet internal sustainability goals and facilitate inter-organizational learning (Reefke & Sundaram, 2016; Schenkel, Krikke et al., 2015; Vachon & Klassen, 2008). The questionnaire results in Figure 10 as well as the findings from the case studies show conflicting viewpoints from the companies in regard to the importance of collaboration. This was evident in the rankings of the factors, where collaboration factors could be found along the full spectrum of the rankings, from the highest ranked position of collaboration with customers, to the lowest ranking which was collaboration with NGOs.

First of all, Collaboration with customers was found by the companies to be the most important factor for enabling SVC. The main ways that companies are collaborating with their customers include collaboration for problem-solving, collaboration for product design, and collaboration in finding the best methods for product use and maintenance. Customer

collaboration is important to address for companies who are employing circular business models, because when customers are satisfied with the product or service they are receiving, they will be more likely to adopt a lifestyle of use over ownership, thus further generating the demand for more circular products and services (Florin et al., 2015).

Second, companies also understood the importance of the suppliers and collaborating with them on product design considerations. Suppliers can equally contribute to value creation and at the same time be accountable for issues with sustainability within the supply chain (Koplin, Seuring, & Mesterharm, 2007). While companies are collaborating with suppliers to ensure circularity of their products, they also understand that they need to address challenges such as intellectual property issues and the resistance of suppliers to sharing information. Therefore, it is clear that increased transparency is needed to create successful long-term collaborative relations that create a win-win situation for both the company and the suppliers in regards to sustainability efforts (Nishat Faisal, 2010).

Third, in regard to employees, the theory supports giving ownership to employees as well as empowering them because it is important for them to see their own successes and for them to gain new knowledge to overcome barriers to change (Doppelt, 2003). The findings are in line with the theory as collaboration with employees ranked as one of the highest factors for the Organizational category (Figure 14). This was reflected in the statements made by Gispen who stated that the employees and the organizational culture should come first, and then the strategies, methods, and tools follow. Furthermore, Gispen also made clear that employees should be involved in initiatives and should be recognized for their achievements. The theory also finds that collaboration *between* employees is important. Lozano (2008) states that in order for sustainability initiatives to succeed, the employees or the individuals and groups within the organization must collaborate together at the same time, while modifying their attitudes (i.e., learnings, feelings, behaviors). Many of the interviewees had a role in the company that focused on communicating within the company about sustainability or the circular economy. Such individuals included the interviewee from Canon holding focus groups for the Circular Economy, as well as the interviewee at Ahrend, whose main position involved communicating about sustainability goals and initiatives to the different departments.

Fourth, the findings from this study depart from the literature in that the factors concerning collaboration with NGOs, the community, and the government were given some of the lowest rankings by the companies (Figure 10). This is an interesting finding, since every company that participated in this study has an existing partnership with a non-profit, sector organization, or a commitment to community involvement such as Interface and Rework by ROE. Furthermore, many companies are involved in initiatives with the government such as Gispen with the Use-It-Wisely project, Ahrend with DBFMO projects, CRS Holland with hazardous waste collection, and Thermaflex with the RACE program. More importantly, the government and the types of legislation that they pass in regard to remanufacturing are of significant importance to companies such as Caterpillar. It seems unusual that the companies would consider collaboration with this group of stakeholders as least important in view of the extensive involvement they have with these groups; perhaps as a topic of further discussion, companies could try to determine how much collaboration with these groups really impacts the process of sustainable value creation.

Finally, cross-functional collaboration is key for actors both inside and outside the company boundaries, where it is imperative that functions in the forward supply chain are closely linked and take into consideration the reverse supply chain (Mollenkopf et al., 2011). The interactions analysis that resulted from the interview coding process shows that these cross-functional relationships or collaborations were present within the companies as the greatest number of interactions took place between Social/Relational and Operational factors (Appendix 5). This gives an indication that through the Social/Relational factors "collaboration" is occurring along with the operational factors, which can be attributed to the "functions" within the organization. Specifically, one factor interaction that was mentioned multiple times included a two-way interaction between *shipping and logistics* and collaboration with *inter-firm partners* such as third-party recyclers. For example, the Ahrend Reuse program is set up with a partnership for shipping, since the company understands that they are not as capable as these partners in the area of reverse logistics. There was also a three-way interaction between the *purchasing function* and *suppliers* in regard to collaborating on *product design*. This is important to note because any decisions made by the purchasing team together with suppliers in regard to product design will greatly affect the reverse supply chain when the product is ready to be returned (Zhu, Sarkis, & Lai, 2008). This specific interaction between purchasing and suppliers is fully to be expected because in an operational and business environment, the purchasing group is inextricably linked to suppliers, since the suppliers are the ones who provide the companies with the materials and products for their businesses. However, it is important that the interactions take the form of collaboration, and do not simply represent efforts to achieve compliance or to meet basic requirements (Foerstl, Azadegan, Leppelt, & Hartmann, 2015).

Other interactions were found within factor categories (e.g. Organizational with Organizational) that had less to do with collaboration or cross-functional relationships. The interactions within factor categories were found in more than one instance, such as in product design and product life-cycle management, organizational alignment and company culture/philosophy, and wireless communication/sensors and IT information sharing. The existence of these interactions is logical as these factors are interrelated and can strengthen each other, for example, in the way product design for remanufacturing can lead to longer life cycles for the product. Similarly, organizational alignment helps to foster and spread the organizational culture throughout the levels in the organization while finally, wireless communication technologies enable information to be transferred between supply chain partners. This study raises the question of the overall significance of these types of interactions and how much they may or may not contribute to a higher level of sustainable value creation, a topic future studies in this field could address.

Another important theme in the literature, relating to "soft" issues, is in regard to leadership, which is noted as being a critical factor that needs to be addressed when making strategic organizational changes, such as in the CLSC development process (Clifford Defee et al., 2009). Furthermore, Rashid et al. (2013) also consider top management to be essential in carrying out more radical changes. The questionnaire and the case studies both supported these theoretical findings. This was recognized by several companies as reflected in their utilization of non-traditional leaders such as CSR champions or ambassadors, as well as the strategic focus that many of the company CEOs had on sustainability. Furthermore, the case study results showed that top management, and especially CEOs,

were seen as establishing and supporting the strategic goals, and the champions and non-traditional leaders were seen supporting the mindset and culture and integrating the goals into the organization. Thus, the results of this research indicate that when addressing organizational changes such as moving towards circular systems or in this case, development of CLSCs, the appropriate mindset and the culture must be established first throughout the organization and furthermore facilitated through the efforts of leaders.

According to Toyasaki, Wakolbinger, and Kettinger (2013), Information Technologies are increasingly important in the development and operational aspects of managing reverse supply chains. Parlikad and McFarlane (2007) and Jayaraman et al. (2008) further point out that specific IT tools such as monitoring and tracking systems such as RFID tags are critical because they provide information for end-of-life decisions and help to improve responsiveness between supply chain partners. The findings from the study show mixed results when compared to the theory. Overall the Technological factors were ranked the lowest overall in importance, while at the same time, in the case studies many companies mentioned the use of diagnostic and monitoring technologies to enable information and data collection regarding the usage of products, as well as for maintenance purposes. Furthermore, companies Gispen and CRS Holland are acknowledging the importance of looking into technology for the future to further enable the coordination of more efficient and effective recovery systems. Based on these results, it could be argued that companies are missing out on a possible key category of factors that could enable SVC. However, possibly because of the operational limitations or costs involved with upgrading information technology systems, companies may be delaying the implementation of new technologies that could help to enable product recovery.

The topic of Product-Service Systems is becoming more prevalent in the literature where the importance of these business models has been associated with prolonging the life of products and minimizing the amount of materials flows in the market (Tukker, 2015). The results of this study reflect a similar focus on product design since the most important factor within the Operational category in Figure 13 was after-sales and recovery services. This is also evident in the results from the questionnaire that emphasized the importance of the product-service systems (PSS), and pay-per-use business models that companies were utilizing, for example, the newly created product-service based model seen in the M-Use® Program by Mitsubishi Electric which includes fixed service contracts that include maintenance and repair, as well as the option of utilizing pay-per-use services as needed. Furthermore, companies such as Bundles, Gerrard Street, and Philips are focusing on business models that emphasize the use and benefits of services over the ownership of products.

Much of the literature on CLSCs and reverse logistics states that product design must be a priority for companies, because the design of the products can affect not only the quality, function, and life-span of the product, but also the ability for the product to be reused, remanufactured, or recycled (Go et al., 2015). According to the results, product design ranked 11th out of 30 factors, and was ranked fairly high within the Operational factor category (Figure 13). Furthermore, it was also found to be an important theme within the case study findings. Companies have stated that when addressing product design, the ability to be able to break down the materials for reuse or recycling is very important. For example, CRS Holland is trying to convince the telecom companies to design their cables in a

way that allows for CRS Holland to separate the main components of steel, copper, aluminum, and plastic after they recover the cables so that they can easily distribute those materials to other partners for new uses. Other companies such as Interface, Caterpillar, Vanderlande, Interface, and Ace Wikkeltechniek also recognized the importance of collaborating with supply chain partners as well as the customers on product design considerations, including aspects relating to choice of materials, designing for operator use, as well as design for remanufacturability.

Additional aspects of the findings relate to new factors that were not originally considered in the questionnaire that represent challenges companies are facing in closed-loop supply chains. First of all, companies such as those within the startups sector mentioned that funding and scaling up the company is the most important factor to consider when developing circular business models. One of the companies, Gerrard Street, mentioned that in order to scale and get more clients companies must have proper funding, and at the same time, to have additional funding, companies must rely on clients. This challenge makes it difficult for startups to address other factors like technology or operational aspects before the economic situation is fully developed. One specific organization that is helping to fund new startups is Climate-KIC, who works with new entrepreneurial companies to help them develop their business models that relate to sustainability and the circular economy (Climate-KIC, n.d.). The literature that was reviewed in this study did not specifically address these items, and was not explicitly found in the comprehensive study by Schenkel, Caniëls et al. (2015). However, that study does address revenue generation including increased market share, increased sales, or access to new markets, but does not mention the specific point of funding, or the role that external parties such as banks or other organizations would have in the process. Second, companies like Gispen spoke about the need for business processes and accounting transactions to be transformed from a traditional way of thinking in strictly industrial terms into a system that also takes into account sustainability and circularity. Organizations such as the Ellen MacArthur Foundation are addressing this point as they understand the importance of companies having the ability to measure or apply indicators to circularity in order to be able to quantify benefits (i.e. value creation) and to measure and track progress (EMF, 2014). However, when looking strictly at the scientific literature, it does not address this topic in detail. A few studies look into indicators for measuring social aspects of reverse logistics or supply chain performance (Mota et al., 2015; Nikolaou, Evangelinos, & Allan, 2013), but there is a significant gap in the CLSC literature relating to more comprehensive sustainability or circularity indicators.

6.3 Limitations of the Research

6.3.1 Limitations of Theoretical Model

One of the limitations of the theoretical model is that it does not take into account a time perspective. Therefore, it is only suitable to look at the results and findings in a context that relates them to the current state of each company's sustainability efforts. It would be interesting to have separate models for past, present, and for the future. That would enable companies to use them as tools to determine which state they are in and where they need to go. Furthermore, the overall structure of the model places all of the categories on the same

level. From the findings of this study, it can be stated that the soft issues or Social/Relational and Organizational factors ranked highest. Since this was the case, it may be important to determine if the model should be constructed in layers of factor categories. For example, Social/Relational and Organizational aspects could be on an outer level and addressed first by organizations, followed by the internal secondary level of Operational and Technological aspects. However, based on the research and the amount of data collected it is not feasible to fully determine if this would be a necessary or accurate modification to the model. Further research would be needed involving a larger pool of companies to gain more insight into the above proposition. Furthermore, the way that future models may be constructed could vary among sectors and types of companies, especially for the startups sector.

Another limitation to this study is that it only broadly looks at the roles of CLSC companies as either producers or third parties. Within the reverse supply chain (RSC) in the closed-loop supply chain visualization model (Figure 5), there are multiple actors and companies that are involved in "closing the loop" that are not explicitly referenced. The part of the model in the RSC that represents the "disposition" of materials could be more clearly defined to include the different activities within disposition. These RSC actors are important to account for as they help to integrate the CLSC system, and enable recovery for companies who are at the source of the entire system. A more in-depth model could be created for future studies to place these RSC actors into specific roles and positions within the model. For this study it was not critical, as the main goal was to determine which factors companies are addressing within the CLSC as a whole.

6.3.2 Limitations of Study

One limitation of this study arises as to the specific factors that were found to enable sustainable value creation (SVC). This study includes thirty total factors that were gathered from many different backgrounds and literature and covered an extensive amount of themes and topics. Thus, only a general overview of the factors was achieved, and no in-depth study of value creation could be provided here. In the future, each of the factor categories could be investigated more thoroughly to see how each contributes to SVC.

Another limitation to the study is that the main interviewees for the case studies included those in sustainability, sales, or upper management roles. In the future, studies could focus on one company or multiple companies and interview several people fulfilling different roles, which would add another level of information to this research. Getting the input of the lower levels in the organization may provide additional perspectives and lead to recommendations for improvement that may not be evident to the upper levels of the organizations. Furthermore, insight into the different operational roles would allow a researcher to understand how specific roles such as purchasing view the specific factors that relate to supplier collaboration or to the purchasing department in general.

One of the goals of this study was to compare the practices of companies and the factors they address to what the research determines will lead to the manifestation of sustainable value. It is possible that companies can create sustainable value by addressing certain factors or interactions, but it is often challenging for companies to prove the actual level of sustainable value created. In addition, it is complicated to understand the reasoning

or drivers behind the efforts in creating sustainable value. Schenkel, Caniëls et al. (2015) make an important point about value creation by stating that often companies either implement strategies intended to create added value or only to reduce risks. From the findings it is hard to determine if the strategies of the companies are in fact primarily aimed at risk reduction or for value creation. For example, joint ventures may be created for economic value creation in some cases, but if a company makes the effort to utilize specific tools or relationships in a strategic way that addresses economic, social, and environmental aspects, then joint ventures can lead to sustainable value creation. The confirmation of this type of information is outside the scope of the study, but should be addressed on an exploratory level to help the companies address these aspects in the future. To determine the level of sustainable value created as well as identifying motivations behind strategies for value creation will require further studies including additional data collection over a longer period of time.

6.4 Further Research

First of all, in the development of the theory and framework of this study, many different ways of referencing certain terms were encountered. Within the scientific community there are a wide range of terms that are being used in the literature that are closely related, such as sustainable supply chains, green supply chains, closed-loop supply chains, circular supply chains, closed-loop systems, reverse logistics, and the circular economy (Agrawal et al., 2015; Difrancesco & Huchzermeier, 2016; Elbounjimi, et al., 2014; Khor & Udin, 2013; Quariguasi et al., 2010). In addition, there are conflicting definitions of terms, such as within the CLSC literature where a certain author refers to open-loop supply chains as linear systems in which materials are not recovered and are put into landfills (Rashid et al., 2013), while another author may define open-loop supply chains as systems in which a third-party actor carries out the recovery and reuses the products (Genovese et al., 2015). Further consensus must be built within the scientific community in the future literature to clear up some of this confusion. Furthermore, certain studies have a technology-based approach that focuses on traditional supply chain literature, while on the other hand; other studies base their research on the Circular Economy (CE) and Sustainable Development (SD) themes (Nasir et al., 2016). There are few studies that combine the two areas and focus on CLSCs and the CE together, and thus, this would be an area that is worthy of further study in the future (Reefke & Sundaram, 2016).

This study and resulting case studies gave an overview of the different types of recovery loops that specific companies and sectors participate in. However, it is difficult to determine the full extent of how developed each loop is. It would be interesting to more deeply explore how to capture the development process of each of the loops and to understand which loops may be more difficult than others to fully develop. Additionally, further studies could look into what specific strategies would be appropriate to apply for each of the loops, not only for the original product manufacturers but for the third party actors as well. In regard to specific strategies, a complete barrier and strategies analysis would be helpful. In this paper specific barriers, or challenges, were discovered and compared to those described in the literature, and some recommendations and solutions to these issues were mentioned by the

companies. To fully address these issues, an in-depth study would be best to match specific barriers with strategies that would help to overcome them.

While this study was comprehensive in addressing multiple sectors, further studies would benefit from researching additional sectors. For example, expanding this research to different sectors such as chemical, construction, steel, or paper-processing sectors may be important, as they are highly energy-intensive and can have adverse environmental effects, and these sectors are often in the early stages of development in emerging economies (Heshmati, 2016). Beyond these sectors, the textile and fashion industries or the food industry, such as consumer packaging and food waste may be relevant to investigate (EMF, 2013a; EMF, 2013b). Finally, renewable technologies such as wind turbines and solar panels are often referred to as inherently "sustainable," but within the realm of the circular economy, technologies like solar panels have critical resources that are difficult to recycle and will require maintenance and repair that will be costly and energy-intensive (Murray et al., 2015). Studies that focus on what these companies are doing to ensure their EOL products and critical raw materials are being addressed during all stages of the life-cycle, especially during the product design phase, could be further researched.

The case study companies that were included in this research were located in both Europe and the U.S. However, different countries, especially those with developing economies, such as China or India are dealing with issues that impact sustainability, such as changes in legislation and are trying to account for the rising middle class and the demand for more materials and products (Hung Lau & Wang, 2009; Rashid et al., 2013). Therefore research is necessary on how emerging markets are dealing with the development of these types of CLSC activities, as compared to a country such as the Netherlands, which has already been making significant progress in regard to the circular economy (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013).

This paper for the most part focuses on companies that were well established and are working on recovering their own products. It would be interesting to have more insight into the types of companies that are now being started or created to help close the other part of the loop, such as CRS Holland where the business model is specifically designed to fill the gaps that exist in the reverse supply chains of the original manufacturers. Furthermore, companies such as these emerging startups may be asking themselves how they can begin the process of establishing new business models. To address this, future studies could focus on what key requirements and strategies for startups would help to enable the success of CLSC systems from the starting point of the business development process.

7 Conclusion and Recommendations

The goal of this research was to conduct exploratory research into the topic of sustainable value creation within closed-loop supply chains. The resulting analysis and findings of this research helped to answer the main research question of the study by carrying out multiple case studies with companies and sectors that participate in closed-loop supply chains. The creation of a theoretical model helped to frame the study to determine specific factors and factor categories, as possible factor interaction that could enable sustainable value creation. This research method helped to address the following main research question: *How are companies addressing sustainable value creation within closed-loop supply chains?* The sub-

questions that have been addressed in this research also provide insights into the main research question and helped to determine which factors companies were utilizing, which factor interactions existed, as well as which recovery loops they participated in. The results from the case studies show that certain sectors are ahead in their development of recovery loops, for multiple reasons such as the type of product, utilization of third party partnerships, or the overall strategy and business model of the companies. Furthermore, there are distinct differences between the types of companies and their position in the closed-loop supply chain such as original product manufacturers and third party actors, who each have different roles and participate in different types of recovery loops. With the growing importance of the circular economy, new companies are being started to fill the gaps in recovery that may be left open by other companies. From the study it can be determined that currently companies are actively looking into ways to create more sustainable value in their recovery activities by addressing specific factors that enable sustainable value creation in CLSCs. Most of the factors that were recognized as being most important to the companies fell into the Social/Relational category followed by Operational and Organizational categories. Technological factors were found to be least important, but companies plan to address these types of factors in the future. Nonetheless, it is still unclear to what extent sustainable value is created and whether these factors will lead to future sustainable value creation. Additional findings, regarding specific challenges that were encountered by the companies, highlighted challenges to SVC with raw material pricing, product return quality, reverse logistic design, as well as employee and customer mindset. Although further research is needed in this area, this study took significant steps towards understanding what factors are critical in the process of enabling sustainable value creation in closed-loop supply chains and thus makes a contribution to the current body of scientific literature.

7.1 Recommendations for companies

Implementing and developing closed-loop supply chains is never a simple task, and no supply chain can ever be 100% circular due to the laws of thermodynamics that explain that at a certain point all materials will reach a physical limit (EMF, 2013a). However, companies can work on improving the circularity of their products and supply chains by addressing specific strategies and objectives. First of all, it is recommended that companies take a more holistic view in regard to the types of strategies that they use to improve their CLSCs, and should account for both social-based "soft" issues such as the employee engagement and collaborative relationships in addition to the more technical and operational based strategies. Moreover, within the organizations, individuals and groups in all functions should be aligned and have a collaborative relationship to enable communication of sustainability goals throughout the organization (Lozano, 2008). Secondly, it is suggested that companies also address collaboration outside the company through inter-firm partnerships such as those involving multiple stakeholders within their supply chains, not only the primary stakeholders such as the customers or suppliers, but also NGOs, the community, and the government (Pagell & Shevchenko, 2014). However, companies should not discount or ignore the possible impact that Technological factors may have on enabling sustainable value creation in reverse supply chains. Coupling technology with pay-per-use

or product-service systems may lead to significant innovations in the future for CLSCs (Florin et al., 2015). Third, it is recommended that companies continue to adopt and implement circular business models, such as product-service systems, and also continue to innovate to extend product life cycles so they can keep products and materials out of the recovery loops for as long as possible. Finally, it is proposed that companies find a way to measure sustainable value creation in order to understand the level of success that results from addressing certain factors. In order to make sustainable value creation measurable, it has been suggested by companies such as Philips, Ahrend, and Gispen that circularity aspects need to be translated into specific indicators. Organizations such as the Ellen MacArthur Foundation have taken steps to develop such a circularity indicator system which accounts for specific inputs such as energy usage, efficiency of recycling, destination after use, and material scarcity that help to calculate the circularity of products (EMF, 2015b).

7.2 Recommendations for NGOs and other organizations

While it is important for well-established companies to further their sustainability efforts and make sure that they physically recover their products, it is not reasonable to expect all companies who produce their own products to be able to handle the infrastructure and costs related to recovery on their own. This represents an opportunity for other companies, such for new startups where this type of recovery is part of their business model, or for established companies such as waste management companies, who can redirect their strategies and begin an entirely new avenue of business activities. Therefore, organizations that have the resources to successfully recover materials should continue to work together through inter-firm collaborations to help to develop the reverse supply chain infrastructure together with the original product manufacturers. As reflected in the comments made by the case study companies, most often, the major methods of finding partnerships are through more unofficial means such as looking online, or possibly through the network of the company itself, for example through contacts the purchasing or sales group may have. Therefore, NGOs and other sector or circular economy focused organizations are important for enabling communication between companies and for establishing collaborative partnerships, especially for finding new usage opportunities for waste materials. Organizations could help to develop new networks and communities that fully encompass all types of raw materials, thereby supporting the goal of industrial symbiosis. One specific pilot program launched by the United States Business Council for Sustainable Development (USBCSD) has developed a “materials marketplace” that works as a collaborative platform that enables companies to work together to find partners for their material streams (USBCSD, 2016). Initiatives such as this project could be applied to different countries and regions in Europe to support similar goals of turning waste into resources. Finally, it is important for organizations such as Climate-KIC to continue to support startups in the aspects of funding as well as business development (Climate-KIC, n.d.). Furthermore, new websites such as the WHEEL program, which focuses on supporting circular startups in the Netherlands, demonstrate the recognition of the importance of these types of companies in the circular economy (WHEEL, 2015).

7.3 Recommendations for policy makers and the government

With the rising importance and global push towards a circular economy, the EU Commission is already taking steps to address many current issues with regard to waste and resources within their plan for the circular economy (EC, 2015). Additionally, the EU government has also issued legislation in regard to product returns such as the waste electrical and electronic equipment (WEEE) directive. Similar extended producer responsibility (EPR) legislation should be expanded within the EU and other countries such as the U.S. to encompass other sectors and products to help promote further development of recovery activities. Moreover, it is advised that the government invest in more research and development for recycling processing capabilities which is especially critical for those sectors in which it is cost prohibitive to recycle products under a certain volume level (Agrawal et al., 2015). Furthermore, the government could partner with other institutions to continue to research new ways of optimizing recycling processes in order to find a way to be able to innovate to allow, for example, the reuse of recycled plastics in the packaging for the food industry. It is also recommended that policy makers continue to work on legislation that makes it harder for companies to put products into landfills, and also make it simpler for consumers of the products to give the products back by creating more advanced networks and systems for recycling multiple types of waste. Further subsidies for companies would be beneficial, in order to overcome the economic restraints that some circular initiatives may have (Genovese et al., 2015). An example of this can be seen in how the UK government is subsidizing insulation materials for energy efficiency purposes (Nasir et al., 2016). Finally, it is advisable to support B-Corps (i.e. Benefit Corporations) and different types of business models that are not solely based on satisfying the shareholders of the company (B-Corp, 2016).

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Appendix 1:

Factor Topic	Factor#	Description/Examples	Source
Collaboration with Suppliers	SR1	Partnerships; Development of suppliers, Vertical coordination and integration, Supplier management, Long term contracts relationships, Supplier auditing, Supplier certification, Supplier Education, Supplier Collaboration	Seuring, & Gold 2013; Schenkel, Caniëls et al., 2015; Closs, Speier, & Meacham, 2011; Beske , & Seuring, 2014; Pagell, & Wu, 2009; Vachon & Klassen, 2008; Theyel, 2006; Tukker, 2015
Collaboration with Customers	SR2	Education, Support, Contact, Customer Transparency, Outsourcing customer, Efficient consumer response, Continuous management attention to customer needs, Customer Collaboration	Schenkel, Caniëls et al., 2015; Huang, & Yang, 2014; Pagell, & Wu, 2009; Rashid et al., 2013
Interaction with the Community	SR3	Volunteerism	Closs, Speier, & Meacham, 2011
Management Collaboration Outside of Company	SR4	Management communication and collaboration, Horizontal Collaboration, Collaborative manufacturing, Stakeholder management, Collaboration w/ value chain partners	Schenkel, Caniëls et al., 2015; Seuring, & Gold 2013; Closs, Speier, & Meacham, 2011
Inter-firm Collaboration	SR5	Strategic Alliance, Joint or collaborative ventures, Collaboration between other industries, Collaboration with competitors, Collaboration with third party logistics, Collaboration with secondary recovery processing, Collaboration w/ global networks, Non-traditional -broader supply chain members	Schenkel, Caniëls et al., 2015; Seuring, & Gold 2013; Pagell, & Wu, 2009
Collaboration with Government	SR6	Relationships with government beyond regulations	Schenkel, Caniëls et al., 2015; EC, 2015; EMF, 2014; Lozano, 2008
Collaboration with NGOs	SR7	Environmental groups, Other non profits, Trade Groups	Pagell, & Wu, 2009; Ghisellini et al., 2014;Matos, & Silvestre, 2013
Collaboration with other Stakeholders	SR8	Shareholders, Other Stakeholders	Schenkel, Caniëls et al., 2015; Matos, & Silvestra, 2013; Zhu et al., 2008

Table 7. Social/Relational (SR) Factor Examples and Sources

Factor Topic	Factor#	Description/Examples	Source
Infrastructure of Information Systems	TC1	Improvement/Updates of IS systems, Dismantling information system, Integrate systems, Logistical integration, Technological Integration, Common IT interfaces & Database structures	Huang, & Yang, 2014; Schenkel, Caniëls et al., 2015; Beske, & Seuring, 2014; Daugherty et al., 2005; Morgan et al., 2016

Business Process Planning Software	TC2	ERP (Enterprise resource planning), MRP (Material Requirements Planning), Enterprise modeling tool, Electronic data log/interchange, Data Collection	Schenkel, Caniëls et al., 2015; Jayaraman et al., 2008; Morgan et al., 2016
Tracking and Locator Systems	TC3	RFID (Radio frequency identification), GPS, Information tracking/real-time information coordination, Track and tracing	San, & Pujawan, 2012; Schenkel, Caniëls et al., 2015; Koppius et al., 2015 Jayaraman et al., 2008
Wireless Communicatio n/Sensors	TC4	Self-monitoring products and diagnostic sensors	Schenkel, Caniëls et al., 2015
IT & Information Sharing	TC5	Information exchange platform, transparency, joint development & collaboration for IT, enhanced communication	Schenkel, Caniëls et al., 2015; Beske , & Seuring, 2014; Gold et al., 2010; Daugherty et al., 2005; Morgan, et al., 2016

Table 8. Technological (TC) Factor Examples and Sources

Factor Topic	Factor#	Description/Examples	Source
After-sales & Recovery Services	OP1	Maintenance, Service Logic, Deposit Fees, Turn-ins, Return policies, Contractual Obligations, Update/upgrade services, Collection and return services, Gatekeeping, Contractual obligations	Schenkel, Caniëls et al., 2015
Certifications/ Standards, Policies/ Procedures	OP2	Standardized policy & procedures; ISO standards, EMS, Continuous Improvement, Lean/Six Sigma, TQM, Value stream mapping, Value Chain Analysis, Quality costing, Activity based costing, Manufacturing Processes (full automation), Standard setting, Standards for End of Life, ISO 14001, Lean management, Supply Chain risk management, Cleaner production, Waste elimination, Redesigning processes	Huang, & Yang, 2014; Schenkel, Caniëls et al., 2015; Seuring, & Gold 2013; Closs et al., 2011; Govindan et al., 2014; Pagell, & Wu, 2009; Rao, & Holt, 2005
Labeling	OP3	Component/product labeling	Schenkel, Caniëls et al., 2015
Product Design Considerations	OP4	Such as Design for X, DESIGN FOR…(multiple life cycles, Core collection, Environment, Disassembly, Assembly, Upgrade, Reliability, Modularity, Maintainability, End-of Life), Design for remanufacture, Green Design, Eco-design, Producing halfway products, Standardization, Product durability/robust design, Customization, Forward and reverse engineering, Snap- fit technology, Material Innovation, Product safety, Product traceability	Go, Wahab, & Hishamuddin, 2015; Schenkel, Caniëls et al., 2015; Seuring, & Gold, 2013; Closs et al., 2011; Khor, & Udin, 2013; Go et al., 2015, Quariguasti et al., 2010
Packaging	OP5	Packaging Reduction	Schenkel, Caniëls et al.,

Considerations			2015; Carter, & Easton, 2011
Product Life-Cycle Management	OP6	Life cycle costing/assessment/analysis, Product audits, Product stewardship, Managing products EOL, Life cycle thinking	Schenkel, Caniëls et al., 2015; Closs et al., 2011; Pagell, & Wu, 2009; Gungor, & Gupta, 1999; Keoleian, & Menerey, 1994; Gurler, 2011
Inventory/ Stock Considerations	OP7	Vendor managed inventory, Consignment stock, Inventory management, Buffer stock, Monitoring stock, Collaborative forecasting and replenishment	Schenkel, Caniëls et al., 2015; Pokharel, & Mutha, 2009; Dowlatshahi, 2000
Sales/ Marketing Structure & Activities	OP8	Functional sales organization, Market generation, Responsible marketing; Licensing-sell designs/processes to others	Schenkel, Caniëls et al., 2015; Closs et al., 2011; Pagell, & Wu, 2009
Resource Management	OP9	Resource commitment, Sharing Resources, Resource allocation, Material substitution, Reconfiguration, Conservation-usage reduction, Waste reduction	Schenkel, Caniëls et al., 2015; Closs et al., 2011; Dowlatshahi, 2000
Purchasing Structure & Activities	OP10	Supplier selection; Strategic Purchasing/sourcing; Flexible sourcing, Buy on total cost not price, Add new suppliers to spur change/innovation, Supplier Continuity (transparency), Local Chain Sourcing, Reducing Supplier Risk, Green Purchasing	Seuring, & Gold 2013; Closs et al., 2011; Govindan et al., 2014; Pagell, & Wu, 2009; Rao, & Holt, 2005; Zhu et al., 2008
Shipping & Logistics	OP11	Bulk shipment, Freight and transport consolidation, Multi-channel collection, Infrastructure improvement, Urban area time access logistics restrictions, Reverse logistics, Logistics transport optimization, Facility location decisions, Flexible transportation	Schenkel, Caniëls et al., 2015; Closs et al., 2011; Govindan et al., 2014; Dowlatshahi, 2000
Supply Chain Considerations	OP12	Network design, Responsive vs. efficient SC design, Integrate forward and reverse systems, Customer decoupling point, Traceability, Reconceptualization of what the chain does and who is in the chain	Schenkel, Caniëls et al., 2015; Pagell, & Wu, 2009

Table 9. Operational (OP) Factor Examples and Sources

Factor Topic	Factor#	Description/Examples	Source
Organizational Alignment	OR1	Responsibility sharing, Alignment of incentives (customer and supplier), Systems thinking, Teamwork, Functional integration within company/coordination, Intra organizational routines alignment	Schenkel, Caniëls et al., 2015; Spekman et al., 1998; Huang, & Yang, 2014; Mollenkopf et al., 2011
Corporate Strategy	OR2	Sustainability rooted in org. culture, Holistic strategy approach, Engaging in new collaborative processes, Service-Oriented Strategy, Servicizing, Eco-centricity	Beske , & Seuring, 2014; Pagell, & Wu, 2009
Collaboration	OR3	Employee Training, talent development,	Closs et al., 2011; Pagell, &

with Employees		sustainable workforce, diversity/inclusion, workplace safety, work-life balance, non-financial reporting, Code of conduct, Employee Incentives, Employee Commitment (high quality work), Sustainability as a recruiting tool	Wu, 2009; Kelliher, & Anderson, 2008; Wilkinson et al., 2001
Leadership Internal	OR4	Senior mgmt involvement, Strategic commitment, leadership innovator, Proactive Management, Commitment to sustainability, Beliefs & behaviors, Written policy, Sustainability goals & practices in every-day SC mgmt-link to strategy, leadership, Informal leaders	Beske , & Seuring, 2014; Closs et al., 2011; Pagell, & Wu, 2009; Rashid et al., 2013: Burgess et al., 2006; Neubert, 1999; Hamner et al., 2008; Gattiker, & Carter, 2010
Company Culture/ Philosophy	OR5	Changing Managerial Cognitions, Responsibility of Sustainability throughout entire organization, Sustainability focus, maintain & build culture formally, Measurement & reward system based on sustainability, Eco-centricity	Pagell, & Wu, 2009; Beske, & Seuring, 2014; Holt, & Ghobadian, 2009

Table 10. Organizational (OR) Factor Examples and Sources

Appendix 2:

Interview Guide

1. What is your main function or role at your company? (Full name, confirm title, time in function, # employees or size of business, local business or global for the recovery loops?)

2. Briefly, can you tell me about your recovery activities and a description of each? (Which type of recovery, which products, how many?)

3. What role do you play in the company's aims of a Circular Economy? What specific part of the supply chain is your function positioned and which recovery loop do you participate in? (Who is responsible for this recovery- Outsourced or 3rd party?)

4. How fully developed or implemented is this recovery loop in your supply chain? Is it a fully closed loop?

5. What percentage of your products comes back through this recovery loop? What percentage actually goes back to the user? (What becomes waste if no longer usable?)

6. What is your view on Sustainability? What are people's perceptions/opinions of sustainability at the company, or within the functions of your recovery loop? In what ways is your company addressing sustainability?

7. What does sustainable value mean to you in the supply chain? Who is responsible for creating sustainable value in the recovery loop?

8. What types of methods, strategies, or tools are used to enable sustainable value creation within the recovery loop system (enablers)?

9. What needs to change for your recovery loop to succeed (enable more sustainable value creation)? What is required to move forward and increase success of closed-loop activities? (May create ideas for new factors, not existing in literature)

10. What are the biggest challenges in enabling sustainable value creation in your recovery loop (barriers)?

11. What is the next step for your company?

Appendix 3:

Questionnaire about the Sustainable Value Creating Factors

Factor Name *Examples*	Recognized in your recovery activities? **Yes/No**	**Yes**, How important are they in creating sustainable value? Scale (1 low importance, 10 high)
SOCIAL/RELATIONAL FACTORS		
Collaboration with Suppliers *E.g. Partnerships, Supplier Development & Certification, Supplier Auditing*		
Collaboration with Customers *E.g. Customer support, Education and transparency*		
Collaboration with the Community *E.g. Volunteerism*		
Management Collaboration outside of Company *E.g. Mgmt. communication, Horizontal collaboration*		
Inter-firm Collaboration *E.g. Strategic Alliance, Joint ventures, Collaboration with competitors, Collaboration with third party logistics*		
Collaboration with Government *E.g. Relationships with government beyond regulations*		
Collaboration with NGOs *E.g. Not for profits, Environmental groups, Sector organizations*		
Collaboration with other Stakeholders *E.g. Shareholders, Other stakeholders*		
TECHNOLOGICAL FACTORS		
Infrastructure of Information Systems *E.g. Improvement/Updates of IS systems, Common IT interfaces & Database structures*		
Business Process Planning Software *E.g. ERP, MRP, Enterprise modeling tool, Electronic data log/interchange*		
Tracking and Locator Systems *E.g. RFID, GPS, Information tracking/real-time information coordination*		
Wireless Communication/Sensors *E.g. Self-monitoring products and diagnostic sensors*		

IT & Information sharing *E.g. Information exchange platform, Transparency, Collaboration for IT*		
OPERATIONAL FACTORS		
After-sales & Recovery Services *E.g. Maintenance, Deposit Fees, Turn-ins, Return policies, Update/upgrade services*		
Certifications/Standards, Policies/ Procedures *E.g. Standardized policy & procedures; ISO standards; EMS, Lean/Six Sigma, TQM*		
Labeling *E.g. Component/product labeling*		
Product Design Considerations *E.g. DESIGN FOR- multiple life cycles, Environment, Disassembly, Assembly, Modularity, Maintainability, End-of Life, Design for remanufacture, Green Design, Eco-design*		
Packaging Considerations *E.g. Packaging Reduction/Design change*		
Product Life-Cycle Management *E.g. Life cycle costing/assessment/analysis, Product audits, Product stewardship, Managing EOL*		
Inventory/Stock Considerations *E.g. Vendor managed inventory, Consignment stock, Inventory management, Collaborative forecasting*		
Sales/ Marketing Structure & Activities *E.g. Functional sales organization, Market generation, Responsible marketing*		
Resource Management *E.g. Sharing Resources, Resource allocation, Material substitution, Waste reduction*		
Purchasing Structure & Activities *E.g. Strategic Purchasing, Local Sourcing, Green Purchasing*		
Shipping & Logistics *E.g. Bulk shipment, Freight consolidation, Multi-channel collection, Reverse logistics, Logistics optimization*		
Supply Chain Considerations *E.g. Network design, Integrate forward and reverse systems, Customer decoupling point; Traceability*		

ORGANIZATIONAL FACTORS		
Organizational Alignment *E.g. Responsibility sharing, Alignment of incentives, Systems thinking, Management Commitment*		
Corporate Strategy *E.g. Sustainability rooted in culture, Holistic strategy approach, Service-Oriented Strategy, Eco-centricity*		
Collaboration with Employees *E.g. Employee Training, talent development, sustainable workforce, Workplace safety, work-life balance, Code of conduct, Employee Incentives*		
Leadership Internal *E.g. Senior mgmt. involvement; Strategic commitment, Leadership innovator, Written policy, Champions*		
Company Culture/Philosophy *E.g. Changing Managerial Cognitions, Responsibility of Sustainability throughout entire organization, Maintain/build culture formally, Measurement & reward system based on sustainability*		

To Interviewee: Any you can think of that were not listed here?

_____

Table 11. Research Questionnaire

Appendix 4:

Category	Explanation
Company Number	The company number will correspond to each specific company interviewed. (E.g. 1, 2, 3)
Factor Interaction	Factor Interactions will be notated by the following: 1 for two factor interaction, 2 for three factor interactions, and so on.
Factor Code(s)	This category represents the code assigned to each factor as per Appendix 1. (e.g. OP3 for Labeling). Each code will either be notated as a singular quote, or two or more factor codes together when an interaction has been found.
Quote Number	Quotes for each interviewee will be numbered, beginning with 1, and continuing on until the last quote (n).
Quote	Specific quote from the interview transcripts

Table 12. Coding Scheme Explanations

Appendix 5:

2 Factor Interaction	Interaction Description	Count
OP1 & SR1	After-sales & Recovery Services ←→ Collaboration with Suppliers	**3**
OP1 & OR2	After-sales & Recovery Services ←→ Corporate Strategy	3
OP1 & SR2	After-sales & Recovery Services ←→ Collaboration with Customers	1
OP1 & SR5	After-sales & Recovery Services ←→ Inter-firm Relationships	1
OP1 & TC1	After-sales & Recovery Services ←→ Infrastructure of Information Systems	1
OP1 & TC4	After-sales & Recovery Services ←→ Wireless Communication/Sensors	1
OP2 & OP10	Certifications/Standards, Policies/Procedures ←→ Purchasing Structure & Activities	1
OP2 & OP11	Certifications/Standards, Policies/Procedures ←→ Shipping & Logistics	1
OP2 & OP4	Certifications/Standards, Policies/Procedures ←→ Product Design Considerations	2
OP2 & OP6	Certifications/Standards, Policies/Procedures ←→ Product Life-Cycle Management	1
OP2 & SR1	Certifications/Standards, Policies/Procedures ←→ Collaboration with Suppliers	1
OP2 & SR5	Certifications/Standards, Policies/Procedures ←→ Inter-firm Relationships	1
OP4 & OP6	Product Design Considerations ←→ Product Life-Cycle Management	4
OP4 & OR1	Product Design Considerations ←→ Organizational Alignment	1
OP4 & OR2	Product Design Considerations ←→ Corporate Strategy	1
OP4 & SR2	Product Design Considerations ←→ Collaboration with Customers	1
OP4 & SR5	Product Design Considerations ←→ Inter-firm Relationships	3
OP4 & TC2	Product Design Considerations ←→ Business Process Planning Software	1
OP5 & OP8	Packaging Considerations ←→ Sales/Marketing Structure & Activities	1
OP6 & OP9	Product Life-Cycle Management ←→ Resource Management	1
OP6 & OR2	Product Life-Cycle Management ←→ Corporate Strategy	2
OP6 & TC1	Product Life-Cycle Management ←→ Infrastructure of Information Systems	1
OP8 & SR4	Sales/Marketing Structure & Activities ←→ Management Collaboration Outside of Company	1
OP10 & SR1	Purchasing Structure & Activities ←→ Collaboration with Suppliers	1
OP10 & SR5	Purchasing Structure & Activities ←→ Inter-firm Relationships	1
OP10 & SR6	Purchasing Structure & Activities ←→ Collaboration with Government	1
OP11 & SR5	Shipping & Logistics ←→ Inter-firm Relationships	3
OP12 & SR5	Supply Chain Considerations ←→ Inter-firm Relationships	1
OR1 & OR2	Organizational Alignment ←→ Corporate Strategy	2

OR1 & OR4	Organizational Alignment ←→ Leadership Internal	2
OR1 & OR5	Organizational Alignment ←→ Company Culture/Philosophy	4
OR2 & OR4	Corporate Strategy ←→ Leadership Internal	3
OR3 & OR5	Collaboration with Employees ←→ Company Culture/Philosophy	1
OR4 & OR5	Leadership Internal ←→ Company Culture/Philosophy	1
SR1 & OR2	Collaboration with Suppliers ←→ Corporate Strategy	1
SR1 & SR2	Collaboration with Suppliers ←→ Collaboration with Customers	1
SR5 & OR2	Inter-firm Relationships ←→ Corporate Strategy	1
SR5 & SR6	Inter-firm Relationships ←→ Collaboration with Government	1
SR5 & TC1	Inter-firm Relationships ←→ Infrastructure of Information Systems	1
TC1 & TC2	Infrastructure of Information Systems ←→ Business Process Planning Software	1
TC4 & TC5	Wireless Communication/Sensors ←→ IT & Information Sharing	2
3 Factor Interaction		**Count**
OR2 & OP4 & OP6	Corporate Strategy ←→ Product Design Considerations ←→ Product Life-Cycle Management	1
OP4 & OP10 & SR1	Product Design Considerations ←→ Purchasing Structure & Activities ←→ Collaboration with Suppliers	1

Table 13. Factor Interaction Details

Appendix 6:

Company	Interviewee Name & Position	Date/Location of Interview	Type of Interview	Length of Interview (min)
Canon	Norah Lewis; EMEA Sustainability and Compliance Specialist	21-Apr-2016; London, UK	Skype call	86 min
Ricoh	Elodie Heintzmann; Environment Manager-Health Safety & Environment section	N/A - Wettolsheim, FR	Written Response	N/A
Philips	Markus Laubscher; Director Sustainability	19-May-2016; Eindhoven, NL	Skype call	55 min
Caterpillar	John T. Disharoon; Director of Market Access/ Business Development	3-Jun-2016; Peoria, IL, U.S.	Face-to-face	92 min
ACE Wikkel-techniek	Eduard Lebbink; Owner-Managing Director	N/A - Horst, NL	Written Response	N/A
Mitsubishi Electric Elevators	Ronald Koedam; Sales Manager Nieuwbouw	N/A - Veenendaal, NL	Written Response	N/A
Vanderlande	Remko de Lange; Strategy & Sustainability	20-Apr-2016; Veghel, NL	Face-to-face	52 min
Interface	Geanne van Arkel; Head of Sustainable Development	2-May-2016; Scherpenzeel, NL	Face-to-face	50 min
Thermaflex	Mirella Zuidgeest; CSR Program Manager	24-May-2016, Waalwijk, NL	Skype call	69 min
Gispen	Karin Verploegen; Legal & Organizational Advisor	17-May-2016; Culemborg, NL	Face-to-face	80 min
Ahrend	Diana Seijs; Coordinator of CSR & Sustainability	23-May-2016; Amsterdam, NL	Skype call	80 min
Rework by Roe	Mark Knepper; Principal-Owner	9-Jun-2016; Chicago, IL, U.S.	Face-to-face	48 min
Monoflo	Andy Schumacher; Director of Distribution & Systems Integration	16-Jun-2016; Milwaukee, WI, U.S.	Face-to-face	36 min
CRS Holland	Arne de Jong; Founding Owner	19-May-2016; Amsterdam, NL	Face-to-face	59 min
Pelican House	Tom Leenders; Founder	15-Apr-2016; Utrecht, NL	Face-to-face	36 min
Bundles	Wouter Buijze; Co-Founder & Sales Director	31-May-2016; Amsterdam, NL	Skype call	50 min

Table 14. Interviewee and Interview Details

Appendix 7:

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http://www.circle-economy.com/case/bundles/
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Table 15. Additional Sources for Case Studies

Appendix 8:

Factor Type	Factor Name	Count (N/A)
ALWAYS APPLICABLE FACTORS		
SR4	Management Collaboration Outside of Company	0
SR8	Collaboration with Other Stakeholders	0
TC1	Infrastructure of Information Systems	0
OP8	Sales/ Marketing Structure & Activities	0
OP11	Shipping and Logistics	0
OR1	Organizational Alignment	0
OR5	Company Culture/Philosophy	0
SR1	Collaboration with Suppliers	0
OP1	After-sales & Recovery Services	0
OR2	Corporate Strategy	0
SR2	Collaboration with Customers	0
SOMEWHAT or MOSTLY APPLICABLE FACTORS		
TC5	IT & Information Sharing	3
TC2	Business Process Planning Software	3
OP2	Certifications/Standards, Policies/Procedures	2
OP5	Packaging Considerations	2
OP4	Product Design Considerations	2
OP12	Supply Chain Considerations	1
SR5	Inter-firm Collaboration	1
OP10	Purchasing Structure & Activities	1
OR4	Leadership Internal	1
OR3	Collaboration with Employees	1
LEAST APPLICABLE FACTORS		
SR7	Collaboration with NGOs	7
TC3	Tracking and Locator Systems	7
TC4	Wireless Communication/Sensors	6
OP3	Labeling	5
SR3	Collaboration with the Community	4
SR6	Collaboration with Government	4
OP9	Resource Management	4
OP6	Product Life-Cycle Management	4
OP7	Inventory/Stock Considerations	4

Table 16. Factor Applicability