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Supply Chain Management – A way to achieve Circular Economy

Master's Thesis in the Master's Programme Supply Chain Management

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Gothenburg, Sweden 2018
Report No. E 2018:064

MASTER'S THESIS E 2018:064

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Chalmers Reproservice

Gothenburg, Sweden 2018

Acknowledgements

This master thesis of 30 credits has been done as the final part of the master programme Supply Chain Management at Chalmers University of Technology. The thesis has been conducted at the department of Technology Economics and Management during the spring of 2018 in collaboration with Chalmers Industriteknik, Nolato and Essity.

We would firstly like to express our gratitude to Martin Svensson Randsalu, Business Development Manager at Nolato and Robert Kling, Technical Innovation Manager at Essity. We are very grateful for the help of providing necessary information for the study as well as all feedback and guidance given throughout the study.

Further, we would like to thank the employees at Chalmers Industriteknik for a warmly welcome and the opportunity for conducting this thesis and also a special thanks to our supervisor Linea Kjellsdotter Ivert, Project Manager at Chalmers Industriteknik. For all the help and feedback, you have provided during the study to make this thesis possible.

We would also like to thank our supervisor at Chalmers, Mats Johansson for provided feedback and guidance throughout the study.

Finally, we want to express our gratitude to all external actor for providing key information to the study.

Alexander Jansson

Mergim Hasanaj

Gothenburg, August 2018

Abstract

Introduction

Researchers describes the objective and purpose of Supply Chain Management (SCM) as value maximization and to optimize the flow of goods from suppliers to consumers. Goods require resources and Stahel (2016) argues that a transition towards Circular Economy (CE) will save the earths resources and increase motivate the main purpose of SCM. Plastic is one of the resources that faces various difficulties, it suffers substantial value losses and effects the environment negatively. Re:Source has introduced a project which faces these challenges that plastic has within a supply chain with the purpose to collect knowledge about SCM and CE. The purpose of the thesis is to create an understanding of the relation between SCM and CE combined with barriers and enablers, increased circularity and value retrievement from plastics.

Theoretical Framework

The theoretical framework supports the structure of the thesis and enables the reader to understand core definitions of SCM and CE. These definitions establish the foundation of the study, the two concepts are defined with recent published literature and some old to grasp fair definitions. To combine and understand the consolidation of the two concepts, real successful cases are presented which will be used as a reference for possible achievements.

Methodology

The thesis is approached as a qualitative abductive research with minor quantitative elements to strengthen the findings. First, background information of the problem was collected to further decide what theoretical framework were most suited. The theoretical framework sets the foundation of the thesis structure. External and internal data is collected through interviews and reports. The trustworthiness of the study is measured in credibility, transferability, dependability and confirmability.

Empirical Findings

Empirical data collection includes two case companies and one plastic recycler. Case company A, Nolato and Case company B Essity provides the insight of plastic materials before it reaches consumers and after it has reached a consumer, pre-consumer materials and post-consumer materials. The empirical findings give an insight of the actual cases from each company the thesis research questions will be found and analysed from these findings. The plastic recycler provides data for the enablers and barriers that the supply chains can face when transitioning to CE.

Analysis and Results

From the theoretical framework and empirical findings an analysis is done to answer the research questions. The analysis shows that there are several opportunities with transitioning from a linear supply chain to a circular economy and that these opportunities differs between procurement, production and distribution. The study has resulted in

numerous barriers and enablers within procurement, production and distribution with transitioning towards a circular economy and answered the questions:

- How can the transition be proceeded?
- Why is the transition towards CE important?
- Who will be involved in the transition?
- What products or materials should be included or prioritised in the transition?

Conclusion

The study concludes that there are different barriers and enablers when transitioning towards circular economy between different companies as well as different departments within a company. It is necessary to identify the barriers and enablers for each specific case to handle the barriers and exploit the enablers for a successful transition. The study also concludes the importance to incorporate circular economy in the business model for a joint effort within the company and that it is important to establish incentives to motivate the transition.

Key Words: Circular Economy, Supply Chain Management, Plastic Material, Circular Economy Business Model, Reuse, Remanufacture, Recycle.

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1. Introduction

The following introduction will firstly present a background that highlights the current issue of value losses within the plastic industry. Secondly, the purpose of the study and the research questions is presented. Finally, the scope will present the cases that has been studied and specify what will be included in those cases.

1.1 Background and problem

Supply Chain Management (SCM) has gained interest among industry and academia since its first public appearance in 1982 written by Keith Oliver (Oliver, 1982). The term SCM spread simultaneously with the 25,000 copies of Handfield & Nichols (1999) originative book "Introduction to SCM" and SCM was referred to; "the culmination of discussion with activities during a whole process of procurement, logistics, and operations". Chopra & Meindl (2007) describes the objective of a SC that "it should maximize the Supply Chain (SC) Surplus", also refeed to SC Value. Other authors and researches agree on specifically value creation purposes for SCM, examples of these definitions are; "goods flow optimization from supplier and material management" (Van Weele, 2010), "a business sense with profits and value incensements" (Wilkerson, 2005), "value adding operations and environmental management interactions" (Bloemhof-Ruwaard et al., 1995) and "value-seeking approaches to incorporate environmental operations like CSR purchasing" (Srivastava, 2007).

Combining environmental aspects and value creation within SCM is an issue even in successful organizations, Diabat & Govidan (2011) and Luthra et al. (2014) finds Circular Economy (CE) as a crucial tool for combining value creation and environmental benefits. The significant global attention of SCM to enhance CE have resulted into a higher awareness level and willingness to fulfil a "closed cycle" from larger companies (Moktadir, 2018).

During almost the entire 21st century environmental issues have been widely discussed, as well as actions that needs to be taken to prevent an unsustainable development. Exploitation of Earth's resources is a particularly large issue where humanity currently consume resources beyond what is sustainable (United Nations, 2012). With around 7 billon people exploiting Earth's resources, there is a risk of them decreasing to unsustainable levels (ibid.). To prevent that resources will run out, it is necessary that we move from a linear economy to a CE (Stahel, 2016). This means that products and materials should not just be regarded as waste after consumption. For instance, parts of used products should be used to create new products, used in recycling or if functionable the product could be used by another user.

To move towards a CE, the European Commission has set goals that should be met by 2030 where products should rise in the waste hierarchy (Tisserant et al., 2017). The waste hierarchy includes five levels; Reduce, Reuse, Recycle, Recover and Landfill where the main goal is to reduce waste and thereafter reuse or recycle products. However, to achieve

these goals it is necessary that used products are collected from customers (Rubio & Jiménez-Parra, 2014). Since used products do not have the same value as new, it is crucial to keep the logistics cost to a minimum when retrieving them. This puts additional focus on SCM as there is a need for an effective return flow, from collecting the products at the customer to transport the products for further processing (e.g. remanufacturing, recycling etc).

One decisive problem is the lack of knowledge for barriers and enablers of working towards a CE. Circularity could result in costly activities that take a lot of time, where some examples are; to collect, sort, disassembly, reuse, remanufacture and recycle depending on strategies and characteristics for each product or material. Material and products are being wasted and not reconsidered into beneficial value for self- and environmental-interest. To understand the possibilities and the value circularity can provide, a wider material flow perspective is needed, SCM offers exactly this, however its missing important measurements and theory to include CE factors. The often defined "linear SC" has potential to develop and include CE activities to further close the chain and ensure sustainable solutions where value losses are minimized.

Plastics is a material that suffer substantial value losses and contributes to a negative environmental impact, this due to the lack of current material recovery. Consumption has increased simultaneously with threats from the material, e.g. each minute 1 million plastic bottles are sold globally and up to 13 million tons end up in the ocean each year (Laville & Taylor, 2017). In Sweden, almost 10 billion SEK of initial plastic value is either burnt or landfilled each year, of these 10 billion SEK only 1.3 billion is preserved which is considerably less than the Swedish material recycling statistics of 53 percent for all materials (Eklund et al., 2015). Ideally 5 billion SEK should, according to the statistics, be preserved from the initial plastic value, which results in 3.7 Billion SEK loss, this is a great possibility to improve and collect value from (ibid.). However, since plastic has a low value compared other materials like metals, there is a need for effective handling of used products to preserve the plastic value. Thereby, avoiding the cost of handling used products exceeding the gained value from circulating the plastic. Therefore, SCM needs to be applied to streamline the circularity for plastic.

The Swedish leading research and innovation investment organization Re:Source has identified that effective material flows is a prerequisite for transitioning from linear SCs towards circular SCs and that SCM theory and practice is of high importance for this transition. Re:Source has therefore started a project with the purpose of generating knowledge about SCM's impact on circular use of material that is led by Chalmers Industriteknik. This thesis is carried out within this project. Desired transition phase requires an understanding of how design, planning, coordination, and control in various SCs can affect and improve CE for a better and sustainable plastic consumption.

1.2 Purpose

Two core values of SCM are; goods flow efficiency and value-adding, which are both vital for an economically sustainable CE. Since used products and production waste have less value than new products, it is important to add value by for example, making used products available to new owner who values it more (reuse), remanufacture the product and make it functional again, or recycle the material content of the product. All three ways of adding value require efficient goods flow to avoid that costs exceed the economic gains of circulating the product or material. So, to transition from a linear SC towards CE, it is vital with effective management of the material flow, in all parts of the circular system. Therefore, the purpose of the project is to create an understanding of the relation between SCM and CE by analysing real case companies and use the gained knowledge to display important "incentives" and "barriers and enablers" when transitioning towards CE. The results are also purposed to showcase the possibilities of value retrievement from plastic material circulation within specific SC areas.

1.3 RQs

Research question 1: The transition towards CE has both enablers and barriers affecting the process. Enablers are factors that increases the SC goods flow efficiency or adds value to the SC, like high quality products, current way of selling the product which supports CE, low volumes of material waste, etc. Barriers are factors in the SC that makes it difficult for transition towards CE like legislation, financial reasons, marketing, an unsupportive business model, vague product ownership, bad coordination with external actors, etc.

- **What are the barriers and enablers for Circular Economy in Procurement, Production and Distribution?**

Research question 2: When CE enablers and barriers for procurement, production and distribution has been identified, it is important to exploit the enablers for the transition towards CE and gain as much value as possible in a SC. To overcome the barriers, it is necessary to establish incentives to motivate the transition and make efforts to solve the barriers. Consolidated definitions of SCM and CE within the areas of procurement, production and distribution will provide essential information for the case companies to achieve circularity. To grasp concepts and important processes the information must be divided and structured. The research question is therefore divided into how, why, who and what.

- **What is important when transitioning a SC towards CE regarding the case companies Nolato and Essity:**
    - **How can the transition be proceeded?**
    - **Why is the transition towards CE important?**
    - **Who will be involved in the transition?**

- **What products or materials should be included or prioritised in the transition?**

1.4 Scope

There will be a focus on the technical part of the CE Model, which is displayed with blue in figure 3. For the circular loops, only Reuse, Remanufacturing and Recycle will be researched in this study. The plastic materials included in this study are all created from crude oil as the raw material. The plastic materials or products which will be covered in the study are divided into pre- and post-consumer plastic. Pre-consumer waste is plastics or products that have not reached an end-user, either because the product has quality issues and cannot be sold or because the material is production waste. Post-consumer waste are products which has reached an end-user and are not desired any more for whatever reason.

To fulfil the purpose and answer the research questions, this study will include two different case companies which represents one whole SC and cover circularity of both pre- and post-consumer waste. The SC activities that are included in the studied cases are procurement, production and distribution.

The following sections will describe the two cases which represents one whole SC, where Case A include pre-consumer waste and Case B include post-consumer waste.

1.4.1 Case A – Pre-consumer

Case A represents the SC activities of procurement and production and display the characteristics of pre-consumer waste within CE. This case will include barriers and enablers for change in the SC activities. Regarding procurement, it is important to understand the field of material- and supplier selection. Regarding production, there will be a focus on waste, both in terms of production waste as well as products that do not meet customer requirements.

1.4.2 Case B – Post-consumer

Case B represents the SC activity of distribution and display the characteristics of post-consumer waste within CE. Case B will provide essential data for the distribution activity and continue the SC from Case A to allow for analysis of both pre- and post-consumer waste.

2 Theoretical Framework

The following section is divided into five different parts, each contributing to answer the research questions and provide the reader with information necessary to understand the report. The first part will firstly define SCM according to theory and secondly define and provide information about the parts of a SC investigated in this study, procurement, production and distribution. The second part will firstly define CE, secondly present business models and logistic within CE and thirdly present incentives for transitioning towards CE. The third part describes successful CE cases within the areas of procurement, production, and distribution. The fourth part provides the reader with information about plastic for a better understanding of the report. The fifth and final part describes the analysis model that is used throughout the report.

2.1 Supply Chain Management definition

SCM has gain much interest in approximately the last three decades and has become a way to gain advantages against competing companies and not just a means to cut costs, where some successful examples are IKEA, Amazon, Dell etc. (Chopra & Meindl, 2016). However, even though SCM has been used for a long time and many companies have had success with it there is not one common definition (Stock & Boyer, 2009). This create problems for researchers since without one common definition it is difficult for researchers to develop SCM theory (ibid.). Without one common definition, development and progress will not build on each other, but instead be improvements in various directions (Liker & Meier, 2006). Further, it also becomes difficult for researchers to define and test relationships between components of SCM and thereby develop the theoretical foundation (Stock & Boyer, 2009). However, most researchers have agreed that SCM includes coordination and integration, cooperation among chain members, and the movement of materials to the final customer (ibid.). To get somewhat of a common definition Stock & Boyer (2009) conducted a qualitative analysis of 173 previous definitions which gave the following definition of SCM:

"The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction."

According to Chopra & Meindl (2016) the typical SC displayed in figure 1 contains a supplier of material, a manufacturer processing the material into products, a distributor and a retailer before the product finally reaches the customer. However, figure 2 is a simplified view of a SC. A real-life SC can both be much more complex and do not always contain all the actors shown in figure 1. There is also no optimal SC, it all depends on the customer's needs as well as the roles played by the actors involved (ibid.)

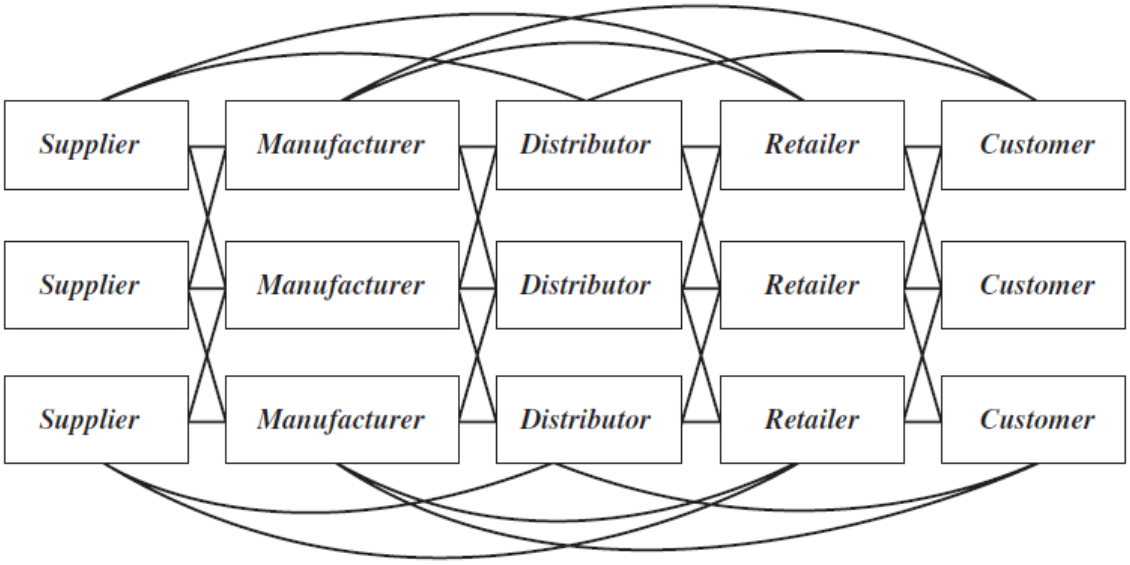

Figure 1: Supply Chain stages. Chopra & Meindl (2016).

Further, it is common that a company has more than one SC in order to reach the customers. The choice of SC is done to maximize the overall value generated, also known as SC Surplus (ibid.).

$$Supply\ Chain\ Surplus = Customer\ Value - Supply\ Chain\ Cost$$

The Customer Value, i.e. the products price, is typically the only external income that is put into the SC and must be shared between all the actors. Therefore, it is important to find the right number of actors to maximize the share for each actor and at the same time reach the customers and provide as much value for them as possible. How a customer value the final product may vary for each individual. According to Chopra & Meindl, (2016) the value can be estimated by the maximum amount the customer is willing to pay for the product.

Figure 2: The investigated SC.

The SC presented in figure 2 is a definition of the SC that is investigated in this study. Procurement represents the action of getting material into the SC that will provide the customers with products. This part will be described from a theoretical point of view in chapter 2.1.1. Production is the action of making products with the purchased raw material. This part will be described from a theoretical point of view in chapter 2.1.2. Distribution is the action of getting products from the focal company to customers through different channels. This part will be described from a theoretical point of view in chapter 2.1.3.

2.1.1 Procurement

Chopra & Meindl (2016) describes procurement as "the process by which companies acquire raw materials, components, products, services, or other resources from suppliers to execute their operations". For direct materials the goal of purchasing is to provide production with components in the right place, in the right quantity and at the right time as well as coordinating the entire SC by matching supply and demand (ibid.).

In recent years there has been more focus on core competence and therefore companies tend to be more specialized (Grant et al., 2017). This has increased the supplier base for most companies, including both national and international suppliers and thereby creating a complex supplier base that needs to be managed. A more complex supplier base is shown by the proportion of a company's spending that goes to suppliers (ibid.). Today manufacturers typically spend around 50-70 percent of their total expenses on purchased items (Chopra & Meindl, 2016). This makes procurement important, since it both has a substantial impact on spending and could also impact the perceived image of a company. According to Grant et al. (2017) the substantial parts of a SC's environmental and social impact stems from the earlier stages of the SC. So, procurement could be considered an activity with major impact on sustainability (economic, ecologic and social) of a SC. Miemczyk et al. (2012) further describes that a company is no more sustainable than its suppliers and due to this, procurement and supply management has a central position for a company's work with sustainability. Procurement could be considered a tool with which a company can control emissions coming from upstream suppliers by screening, selecting and collaborating with suppliers to increase the sustainability of the SC (Grant et al., 2017). However, focus should not only be on direct suppliers but instead on the wider network a company operates in, to fully understand a company's sustainability profile (Miemczyk et al., 2012).

With the procurement activity Chopra & Meindl (2016) present four related risks;

- Exchange-rate risk – the risk related to changes in currencies.
- Price of inputs – means that the price of components can change for a supplier and thereby changing the buyer's price. Most common for raw material e.g. oil.
- Fraction purchased from a single source – is the risk related to having a single supplier and the effects it has if the supplier cannot deliver.
- Industry-wide capacity utilization – is related to the extra costs that occur with an increase in capacity utilization over one entire industry.

Some of these risks are difficult to mitigate while others can be dealt with. To increase their work with sustainability while also mitigate the risk, price of inputs Dell Inc. adopted a CE model (Koch et al., 2017). By developing a global takeback program, they were able to produce 5,000 tons of plastic products from computers retrieved since mid-2014. According to Koch et al. (2017) a closed-loop system provides the market with a more stable price compared to the use of virgin materials, which changes with the used raw

material. Along with stabilizing the price a circular approach also moves companies' dependence from environmentally costly virgin materials to a sustainable source of recycled plastics. To develop a functional circular system there is a need to gather and recycle products as well as creating a demand by purchasing recycled materials (ibid.). Purchasing has an important part in sustainability work where policies and practices need to be incorporated in the whole SC and not just in single companies (Meehan & Bryde, 2011). Further, there must be an increase in supply of high-quality recycled material to allow companies to purchase recycled material that meets all the technical, economic, and aesthetic requirements (Koch et al., 2017).

To both increase and match supply and demand of recycled materials and thereby address environmental sustainability issues, the concept of CE has become one of the most recent proposals (Witjes & Lozano, 2016). Where an important purpose of CE is to bridge consumption and products by transforming products that is considered as waste into resources (ibid.). This further highlight the importance of purchasing regarding sustainability and CE since products considered as waste need to be integrated into production either as recycled material or be remanufactured (Meehan & Bryde, 2011). Meehan & Bryde (2011) also emphasize the importance of really incorporating company sustainability aims into procurement strategies. In the current market it is expected that companies integrate sustainability in corporate goals, however it is common that these goals are not reflected in purchasing strategy and especially practice (ibid.).

2.1.2 Production

Production operations includes SCM activities of various types, i.e. enabling possibilities for set strategic company goals, demand efficiency and mostly important, co-ordination between all activities (Jonsson & Mattsson, 2009). Achieving this co-ordination, Jonsson & Mattsson (2009) distinguishes three levels of control within a SC, Strategic, Tactical and Operational.

Strategic control aims towards decisions which positions the company in desired business environment. The environment is set by goals and visions with actual and realistic directions for the company (ibid).

Tactical control aims at structural development and tactical decisions like procurement and distribution strategies. Controlling resources and materials relies on usually some kind of material resource planning (MRP) system. MRP is a system to enable digital inventory planning, manufacturing planning, supply planning, and general corporate planning. MRP systems has its limitations and disruptions regarding production material planning, if materials are returned in a closed-loop SC, the MRP system will require extensions of the software to handle it (Giunipero, 2014). Product or service design decisions which corporate with the strategic and operational levels are important, the design has its own measures which will be addressed in upcoming section, "Design for life"

Operational control aims at controlling and managing daily activities regarding operational tasks towards the strategic and tactical directions. Operational control is the enabler for achieving set strategies of the company, for example, goals of production volume, minimum production waste levels, enable collection of waste, etc. The operational activities represent the infrastructure towards set goals (Jonsson & Mattson, 2009).

Design for life is a concept from the Ellen MacArthur foundation's research about CE (Webster, 2017). When designing a product, its purpose and use must be established according the strategic control and directives. Make take and dispose is a concept which founds from the Fordism era when mass production and mass consumption revolutionized the industrial market (Stahel, 2012). Services turned into products with inferior quality since mass production often required, and still requires, cheap and fast methods for a competitive price. Designing a product for a service differs from the make take dispose concept, the design requires a sustainable product which can be returned after use, disassembled, or repaired, not harmful to user or the firm and be material efficient (Webster, 2017). Costs related to designing for life can easily be transformed into benefits according to Stahel (2012), long-lasting, reliable, safe, upgradeable, no end-life, no materials which generates wastes are some of many keywords which are defined as benefits for the CE design for life concept.

2.1.3 Distribution

According to Chopra & Meindl (2016) "distribution refers to the steps taken to move and store a product from the supplier to a customer stage in the SC". This refers to the movement and storage of raw material between supplier and manufacturer, and storage of complete products between manufacturer and end customer, usually through a distributor. Distribution networks comprises of numerous different resources where some of these are within the boundaries of the individual firm and others are collective, such as roads, railways etcetera (Ford et al., 2003). These resources are connected, and the business relationships of a company plays an important role in affecting the value of these resources (ibid.). Further, distribution is a key driver of the overall profitability of a firm since it affects both the cost of the entire SC and the customer value directly (Chopra & Meindl, 2016). However, it is common that reducing costs are not the only focus. The appropriate distribution network can also be focused on high responsiveness, at a slightly higher cost (ibid.). According to Ford et al. (2003) the efficiency of distribution can often be increased by moving activities from one actor to another. In addition to moving activities, the movement of ownership of a product could also influence the efficiency since ownership is related to responsibility and costs.

According to Chopra & Meindl (2016) there are two dimensions when, at the highest level, evaluating the performance of a distribution network;

1. Customer needs that are met
2. Cost of meeting customer needs

Thus, a firm must evaluate whether customer service or low cost is the highest priority since it allows for different solutions of the distribution network. Further, Chopra & Meindl (2016) argues that the customer needs that are met influence the revenues and together with the costs of meeting these needs decide the profitability of the distribution network.

2.2 Circular Economy Definition

CE is a circular system where no materials are wasted, but instead included into a value network where Reusing, Remanufacturing and Recycling is three actions to regain material value into a SC. CE is a continuous concept with no ends and will never terminate in the ideal environment (Houten, 2014). Stahel (2013) has developed five principles which characterizes the opposite of a linear SC and applies ideally for a CE concept. The principles define what circularity is and its core values, Stahel (2013) determines a lack of knowledge in linear SC´s and this has reportedly shadowed the economic benefits of CE in organizations. The five principles are (Stahel, 2013. p.46):

1. The smaller the loop (activity-wise and geographically) the more profitable and resource efficient it is.
2. Loops have no beginning and no end; value maintained replaces value added.
3. The speed of the circular flows is crucial; the efficiency of managing stock in the CE increases with a decreasing flow speed.
4. Continued ownership is cost efficient: reuse, repair and remanufacture without a change of ownership saves double transaction costs.
5. A CE needs functioning markets.

CE has still not reached its mature state where a clear definition is globally stated, Ellen MacArthur Foundation with analytics by McKinsey Company have created a technological and biological visualization of how products and materials cycle through the economic system, the cycles can be seen in figure 3.

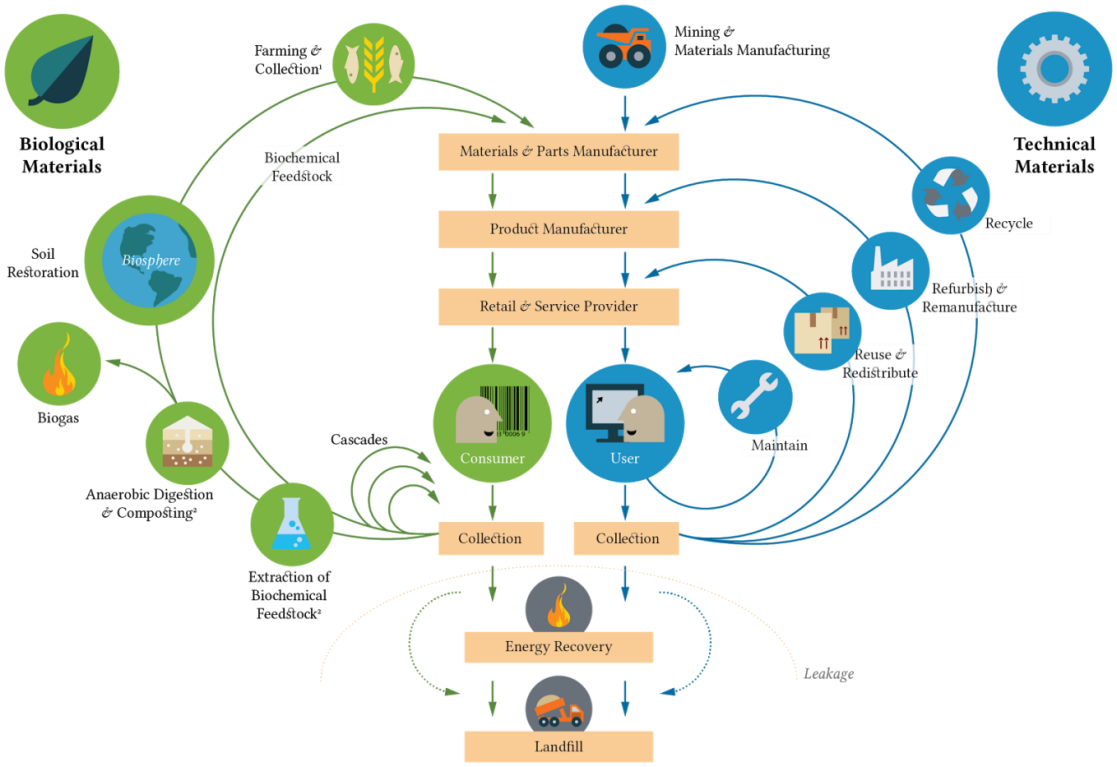

Figure 3: The Circular Economy—an industrial system that is restorative by design (MacArthur, 2013)

The scope and purpose of the report limit the figure into its technical nutrients, the blue cycles to the right. The terminology of its sequences is defined as;

- *Reuse/Redistribute* is when one can reuse a product for the same origin purpose of creation while the product remains, or with minor changes from its original construction.

- *Refurbish/Remanufacture* can be divided into product and component levels, where product refurbishment is when a product reaches a functioning condition through replacements or repairs of defect components. Visuals changes of the product like repainting or cleaning is a part of this cycle. Component remanufacturing is a process of a teardown and components from products are reused for restoration purposes or used for different products with other purposes.

- *Recycling* is a process to recover materials for personal or impartial purposes. Downcycling and upcycling are recycling subprocesses; downcycling is when materials are converted into new materials, within this process quality and functionality can be lost. Upcycling does the opposite and converts materials into more qualitative and functional.

- *Energy Recovery* is a transformation processes of materials into energy, either as heat, electricity, or fuel.

- *Landfilling* characterizes the deposit of waste into land for future use or as filling materials.

- *User* is someone or something that is using materials or products for any use.

CE refers to a replacing industrial system to the linear model of consumption and sieves towards renewable energy and abandon the "take, make, dispose" system, which still is actual since the mass production revolution (Delphine & Laperche, 2016). CE´s objective is to exterminate waste through numerous individual, corporate and social responsibilities. One of many key factors for success, is early involvement of the concept in early phases of creation. One example is through careful product design which applies for reuse, repair, and recycling after final consumption (ibid). Designing with high quality and apply the products to its value network where remanufacturing and repairs on products are possible (Houten, 2014)

2.2.1 Business Models for Circular Economy

According to Zott et al. (2011) a business model represents strategic decisions and structure and they refer to a business model as a statement, a description, a representation, an architecture, a conceptual model, a structural template, and a pattern of work. The definition is complex and has less theoretical value, but it is defined based on its set purpose and projected achievements (ibid). Weetman (2017) focus the importance of a business model as commercial structures and strategies to support goals and directions, and how these develop the organization. CE is dependent on responsibility from all SC actors, coordinating actors with circular activities requires a clear and strong structure. The business model is a company's spine and therefore the importance and relevance of its design is highly prioritised (Stahel, 2013). This section "Business Models for Circular Economy" will focus on why companies should transform and adjust their business model into the market of circularity and CE.

Product Service System (PSS) is argued as an economic solution for circularity and a future business model for a sustainable CE according to researches (Mont, 2002; Manzini & Vezzoli, 2003; Tukker & Tischner, 2006). Its characteristics of allowing companies to retain product ownership during its life-time improves the resource efficiency and traceability, it is even argued that product life cycles will possibly extend for various reasons (Lee et al., 2007). Extending the life time increases material value from each product or material, which fits ideally with CE. Ellen MacArthur (2013) recommends a functional service based economic model for successful CE implementation. A functional service model, like PSS, allows as mentioned a generic ownership of materials or products for extended periods. Functional service models transform the business model and shift from the traditional linear SC of make – take – dispose into a circular service providing models by allowing, when possible, companies to act as service providers rather than product providers.

A change in business model require shifts in functions and principals in the company core. All business model related activities need adjustments throughout the whole SC, procurement, coordination, planning, marketing, warehousing etcetera will be affected (Mont, 2002). Companies will face major changes when implementing a PSS and requires dismantle of current economic models and structure (Cook et al., 2006). The strategic changes extend over a longer period, the benefits, and challenges it brings simultaneously will be discussed further down.

2.2.1.1 Circular Economy Logistics

The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal" (Rogers and Tibben-Lembke 1999, p. 2).

SCs change its linear characteristic once in a CE with Reverse Logistics (RL) and Dr Frei et al. (2015) identifies the downstream activities as essential value recovery of products, components, and materials. The recovery enables loops in the SC with a downstream from product recalls, delivery reclaims, damaged products in transportation/manufacturing or production waste. RL includes careful processes of planning and controlling flows of material, information, and cash. Material flows are stored inventory goods, pre- and post-consumer raw materials or finished goods and its related essentials are part of the information flow, which extends until the point of disposal and value resumption (Rogers & Tibben-Lembke, 1999)

Studies has characterized essential aspects of CE into: why, how, what and who and showed its benefit and relevance when identifying CE possibilities (Thierry et al., 1995; Fleischmann et al., 1997; Zhiquaing, 2003). Dekker et al., (2003) gives a collected definition of what the aspects are and an understanding into the generated issues of RL in a CE, the definitions are:

- **Why** are products, components or materials returned in the flow?
- **How** CE incorporates with RL in daily activities, and how value is preserved within these activities?
- **What** products, components or material is return in the flow and what are its characteristics that motivates the return?
- **Who** is responsible for the actions taken and what is each actors role in implementing a reverse flow?

The involvement of RL is motivated by three main reasons, economic aspects where profit is a driving force is the first and most fundamental from a common sense, secondly, in some cases the option is less, and one is forced to implement it, and finally, the social moral and motivation. Dekker et al. (2003) has defined these three motivations and referrers to them as economic, legislation and corporate citizenship forces.

Economic forces of RL can enhance direct benefits for one by lowering the use of virgin materials by reduction of disposal costs and value retrieval from materials. Activities of strategic directions towards RL enables indirect economic benefits. When economic value is less clear, forces like marketing, competition and strategic issues can drive the transition. Working with CE is well socially respected and one example of using the power for marketing purposes is IKEA. Since 2015 multiple commercials have been broadcasted with the purpose of marketing the work IKEA is prioritizing, which is CE with linked products (IKEA, 2018). There´s still no reports on its effectiveness, however it seems logical with the pursuit and might give competitive advantage. RL and its economic benefits is one driving force for many, Dell, Inc drives a CE program and recovers materials for future products which makes good economic business sense due to the reduction of high price fluctuation and dependency of fossil fuels (Koch et al., 2017). Strategic decisions to work with CE have been identified in early years by Louwers et al. (1999) as; future preparation and prevention from legislations, one must recover its sold items and accept return of any reason (Dekker et al., 2003). Returns of products vary from case to case, the most common are manufacturing-, distribution- and customer-returns. Returns defines the process of sending back items in the SC, also referred as RL in the context. The returns reason is quality issues, over-production, recalls, damaged in delivery, commercial returns, warranty returns, end of use and life returns.

2.2.2 Incentives for Circular Economy

The reasons to shift current SC into a CE may differ for various reasons. The authors define the important and relevant benefits for the cases and includes incentive and business model as important factors to the analysis model in figure 6.

Economic Benefits:

Economic profits are desirable, companies enter markets where profits are the highest however, the joy may not last for long since economic profits invites competition who are interested in the same deal. The competitiveness has challenged SC´s to strengthen its market position with innovative methods to higher the entry barriers for competitors. Economic profits are waved into the balance of competition, in markets with less competitions profits might be higher than markets with high competition (Investopedia, 2018). CE echoes the charisma of environmental benefits and efficient use of resources, while related activities like RL and SCM are deeply cost-effective of its kind and serves for various benefits, one is profit generation. Autry (2005) identifies this consolidation as a vital success factor for many companies. Dowlatshahi (2000) found that specifically RL, which is a related activity to CE, is highly considered in strategic levels for increasing economic benefits.

CE enables contrasting visions of the potential use for resources rather than the issues of management and disposure related to it. Andrews (2015) partly defines the linear SC with economic losses within the subject of material value and that they are blocked when not circulating. Prendeville et al. (2014) sees the opportunities with material circularity and the value that is kept, material value will generate economic value. Material value is

recovered based on the cycle in CE its preserved, Dr Regina Fret (2017), presented a diagram where value recovery could be visualized depending on the CE cycle a product had. The smallest and closest cycle to the user preserves most value from the material or product. Least material value is recovered from materials or products that ends into energy recovery since its burnt up and cannot be reused. The value of fuel and combustion the materials generate are different from material value and can therefore not be analysed with the same measurements (Weetman, 2017). Capturing the value closer in closer loops has been proven to be effective in terms of economic benefits, Jung et al. (2015) researched the cost differences between recycling close to the activity versus off-site at a recycling centre. Transportation, distance, and amounts were enough to motivate economic benefits of recycling on site and were proven to affect the recycling costs.

Product – Service – System Benefits:

Operational benefits of PSS are argued to stabilize the revenues hence the relationship and distance between customers and manufacturers. With PSS the knowledge of operational environments increases, and relationships gets better. Consumers gets their part satisfied as well since quality must be high and environmental aspects are considered objectively (Helo et al., 2017). PSS comes with numerous benefits, Mont (2002) collected some core values of PSS which are presented in Table 1.

Table 1: Benefits of PSS

Organizational benefits	Reclaiming more value on a product.
	Preparing for future growth and development.
	Customer relationship advancements.
	Higher product value for customers.
	Maintaining a high-quality standard of products.
	Maintaining a high market share hence the difficulty of coping a service.
	Higher service levels.
	One becomes supportive of circular consumer behaviors.
	New jobs will be created since services are more labor intense.
Customers benefits	Larger product variety in the market.
	Greater customer specific value into products since customization and quality will increase.
	Flexibility with trends and limitations, services depends on contracts and with a flexible one it is not sensitive to changes.
	Different needs can be covered without instant larger investments.
	Product responsibilities are less due to the fact of ownership.

The economic benefits of CE will apprehensively require some core changes into the fundamental values and business model. Cook et al. (2006) explains the risks with these

comprehensive transitions and why the shift may fail. When not considering all functions and activities within an organization, failure is common. Therefore, an adequate transformation is required. Distinct interest and attention of surroundings can be harmful, companies are often too focused on specifically economic benefits and forgets about social and environmental pros CE can offer (Li et al., 2017).

Trends in CE:

Strategic decisions are mainly decided by humans, and not solely based on numbers, and research has proven that we as individuals do not have the control we might think. Thoughts and behaviours are deeply influenced by someone or something in our environment, one potential factor is trends Muscovici & Zavolloni (1969). Trends in SCM has been identified by Neely (2014), these are characterised with its supplementation.

Solutions will overtake Products: Customers are reaching out for complete solutions rather than single items.

Outcomes will overtake Outputs: Outputs are mainly specifications, e.g. Performance and capacity. Outcomes are included into a service contract and suits both customer and supplier.

Relationships will overtake Transactions: Shifting to CE models require possibly long-term contract if in a PSS, if not traceability will hence be higher opposite to the linear model. A vast and deeper engagement will be required for a functional CE model.

Network partners will overtake Suppliers: The SC complexity will possibly increase and delivering complete solutions requires a relationship with actors who has diverse core competences which are included into the service package.

Ecosystems will overtake Elements: Ecosystems, or supporting network around the organization like, competitors, suppliers, customers, capabilities trends etc, are used to influence strategic directions.

Corporate Social Responsibility:

Corporate Social Responsibility (CSR) main purpose is to objectify actions of social responsibility. The responsibility relies within the terms of CSR on larger corporates thus its size and transparency towards the society (Rayman-Bacchus, 2004). Competitive advantages can be achieved through CSR strategies and political directives, McWilliams et al, (2002) prospects that CSR can be used for sustainable corporate advantages. González-Rodríguez et al. (2015) researched the possibilities of CSR´s role in strategic management and was proven successful between consumers and corporates. Three dimensions were identified and analysed from a large set of researches, the dimensions which represent CSR are Economic, Social and Environmental, these dimensions are essential for a successful CSR adaption (ibid).

Economic aspects of CSR consist of direct and indirect economic impacts of SC´s operational activities towards the other two dimensions. The economic aspects are not related to financial objectives nor economic issues related to the SC (Uddin, Hassan, & Tarique, 2008).

Social aspects of CSR consist of direct and indirect social impacts of the SC´s actions have on people. The social aspect relies on responsibilities towards customers and ensuring that offered products or services are fair and does not discriminate, offend, or cause any social harm in any way (Uddin et al., 2008).

Environmental aspects of CSR consist of direct and indirect environmental impacts of the SC´s actions have on the planet. Taking responsibilities for environmental damage require activities throughout the whole SC to adapt. Choice of suppliers, materials, transportation, marketing are few SC activities that has to be adapted for the environmental dimension of CSR (Uddin et al., 2008).

Legislation – EU:
One of the most important reasons for companies to implement CE within the company is upcoming legislation from the European Commission (European Commission, 2018). In January 2018 the European Commission adopted a new set of measures to continue the effort of transforming Europe's economy into a more sustainable one and to implement the CE Action plan (ibid.). From their pre-study the European Commission identified the following key challenges that need to be dealt with:

- **Increased Production -** Global production of plastics has increased twentyfold since the 1960s to 322 billion tonnes in 2015 and the current level is expected to double over the next 20 years.

- **Value Losses -** Reuse and recycling of end-of-life plastics is low compared to other materials. Around 25.8 million tonnes of plastic waste are generated in Europe every year and less than 30 percent of this waste is collected for recycling. Further, the levels of landfill and energy recovery are at 31 percent and 39 percent respectively and according to estimates around 95 percent, corresponding to EUR 100 billion, of the value of plastic packaging material is lost to the economy every year.

- **Lack of demand –** Demand for recycled plastics today accounts for only around 6 percent of plastics demand in Europe. Due to low commodity prices and uncertainties about market outlets there has been a lack of investments in plastic recycling.

- **CO_2-emissions –** Combined, plastics production and energy recovery of plastic waste contributes with around 400 million tonnes of CO_2 every year. By using more recycled plastics the dependence on fossil fuels can be decreased as well as

the level of CO_2-emissions. With the achievement of recycling all global plastic waste it is possible to save energy equivalent to 3.5 billion barrels of oil per year.

- **Plastics in the ocean –** Every year 1.5 to 4 percent, corresponding to 5 to 13 million tonnes, of the global plastic production end up in the ocean each year. It is estimated that plastic accounts for over 80 percent of marine litter and the damage to marine environments is at least USD 8 billion per year globally.

In order to mitigate the challenges mentioned above the European Commission will implement actions within the following areas from 2018 and onwards:

- Improving the economies and quality of plastics recycling
    - Actions to improve product design
    - Actions to boost recycled content
    - Actions to improve separate collection of plastic waste
- Curbing plastic waste and littering
    - Actions to reduce single-use plastics
    - Actions to tackle sea-based sources of marine litter
    - Actions to monitor and curb marine litter more effectively
    - Actions on compostable and biodegradable plastics
    - Actions to curb microplastics pollution
- Driving investment and innovation towards circular solutions
    - Actions to promote investment and innovation in the value chain
- Harnessing global action
    - Actions focusing on key regions
    - Actions in support of multilateral initiatives on plastic
    - Actions relating to bilateral cooperation with non-EU countries
    - Actions relating to international trade

2.3 Successful Circular Economy Cases.

This section includes real cases of companies within plastic production or distribution, the cases will provide real successful circular cases in terms of methods for CE. The cases operate in circular loops, either with reuse, remanufacturing or recycling within the three SC activities of procurement, production, and distribution. The purpose of these successful CE cases is to understand the potential of CE and possible barriers and enablers. The cases wrap up and summarizes the most important factors when working towards a CE, Business model for CE and Incentives for CE. These factors are chosen based on theoretical framework and these successful cases. An illustration of how the SC from figure 3 is related to the factors is displayed in figure 4. The cases will also develop an understanding of how CE activities can be performed. Example, how recollection is made, how ownership is retained, how value can be preserved etc, these refers to the circular loops and its enablers.

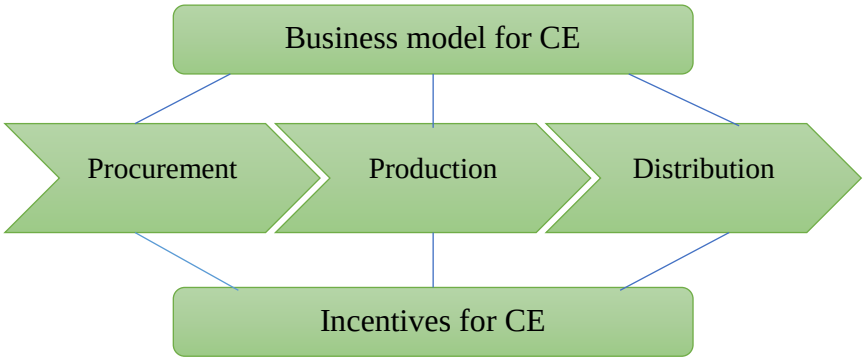

Figure 4: SC and important SCM factors for CE.

Xerox Corporation – Remanufacturing and Recycle case example:
Xerox Corporation is a global American corporation who sells office solutions within print and digital documents. Their largest product segment within the assortment includes printers and copy machines for larger organizations and individual consumers, however, their largest market is for organizations like offices, schools etc. Xerox introduced their Cartridge Return Program in 1991 and covers up to 80 percent of the total cartridge supply and they have a cartage return rate of 60 percent in Europe and US, this corresponds to 2.86 million kg of material which is remanufactured or recycled. The internal recollection enables Xerox to always know what plastic materials are included in each product for a smooth recycling and remanufacturing. The program has expanded and developed since 1991, today the programs are named EcoBox and Green World Alliance.

EcoBox is a program for recycling and remanufacturing of consumable materials if one has; a high usage of tone cartages, and a high usage of devices within same segment and requires continuous pick-ups. Xerox provides larger users with the EcoBox and collects consumed materials. When the EcoBox is filled, one is required to contact Xerox through the internet and order a pick-up. The EcoBoxes will be recycled as well.

Green World Alliance is a program which minimizes the environmental impact which can occur if Xerox products end up in wrong hands and not handled with recycling or remanufacturing in mind. The program aims towards consumers with smaller usage and is probably an average consumer. The program co-operates with the whole SC and if not well coordinated with the whole chain disruptions will occur. One example is the design of packaging, the packaging product are sold in will work as a packaging for the used and soon returned product. Xerox has included designers to enable recollection and is successful doing this. The consumer is well informed about the process and is directed to the homepage for identification of returned product and a label for transport including the bill of material and addresses is generated for every customer free of charge, Xerox also pays the transportation.

SodaStream – Production and Reuse case example:
Changing the habits and reducing one of the biggest issues in the plastic market, SodaStream has taken its size and market position to change and influence the market.

Plastic bottle waste is a global issue and addressed by the European Commission (European Commission, 2018). SodaStream´s business model reduces not only plastic bottle waste but also postpones carbonation of water. The postponement reduces transportation costs and manufacturing of plastic bottles. SodaStream offers the possibility to carbonate and flavour regular tap water in their reusable bottle which is designed for a long-lasting life with high quality and standards. The reusable bottle is well identified of materials for future recycling, however, the purpose is to reuse it as long as possible with no planned life time and for this purpose plastic is shift into glass for a lifetime usage. The plastic design is performed with durability and quality as main priority and the design is less important with some compromise to stay in line with current business model.

Renault – Recycling and Closed-loop Supply Chain case example:
In collaboration with Renault Group, Ellen MacArthur Foundation (2017) did a case study on Renault's work with CE. Renault Group provides vehicles and parts to 125 countries and in 2016 they sold more than three million vehicles. In the study they describe that Renault has realised that pursuing a CE makes good business sense as a strategy for optimising resource use and minimising environmental impact. Their strategy includes remanufacturing of engine parts, creating a second life for electric batteries, and increasing recycling of raw material in the sector with the goal of keeping as much material as possible in the local automotive industry. To pursue this idea, Renault set up an experimental platform for end-of-life vehicles with the goal of having a completely closed-loop and thereby putting materials from end-of-life cars into new cars without compromising with quality. Currently, 36 percent of the total mass of new Renault vehicles in Europe is made from recycled materials and 85 percent of an end-of-life vehicle is recyclable.

However, the SC for recycled plastic is poorly developed, and the lack of a predictable and secure stream of materials creates difficulties in planning manufacturing operations. Therefore, the goals of Renault's experimental platform were to secure a stable supply of materials and thereby, in the long-run, lower the cost of recycled material compared to virgin materials, thus creating positive revenues for all players in the SC. Further, another driver is the European Directive that requires handlers to reuse and recycle 85 percent of an end-of-life vehicle and use 10 percent for energy consumption.

One of the most important conclusions from the study is that collaboration is key for optimising the system of circulating materials. According to Ellen MacArthur Foundation (2017), "circular thinking views the economy as an ecosystem of businesses, shifting away from throughput as a measure of economic health and focusing instead on the optimisation of the system as a whole". Further, they describe that accessing raw materials is no longer just about procurement, but instead focused on coordination and collaboration across the industry to secure a stable material flow of recycled materials.

Axjo – Procurement, Production and Recycling case example:
Axjo is a world-wide company that mostly produces solutions for storing cables on different kinds of cable drums. Further, Axjo is a company that has come a long way in the areas of sustainability and CE. According to their website, they have due to their position as a global operator realised that they need to have a long-term approach to environmental and sustainability issues. This is incorporated in both the products and the production process, where they have divided their sustainability work into the four areas of *mono-materials*, *circular economy*, *logistics network* and *traceability* (Gaardsdal, 2018).

All the products that Axjo produce are manufactured using the *same material* within the entire product and throughout the entire product range. By using the same material all products become easier to recycle, since they eliminate the need to dismantle and sort the materials prior to recycling. Instead, their drums can be recycled in one piece and thereby saving time, resources and money. With their holistic view of sustainability, they have adopted a *CE* where the same products remain in the system. This means that their products are collected, recycled and returned to either their own production or the market. By combining this with intelligent material handling and carefully selected logistics solutions they are allowed to make long-term strides towards minimizing their environmental impact. To improve the sustainability of their *logistics network* they work with improving space utilization to minimize volumes and weight during transport. This is done by making products that are stackable and easy to dismantle. Finally, by working with *traceability* they can maintain full control of their material. This applies to both the origin of materials and the final use of products, which allows them to improve error-identification and proof the extent of their overall environmental responsibility.

Redi-Box – Distribution and Reuse:
Redi-Box´s mission is to transform the weak cardboard moving boxes, into recycled plastic boxes while retaining the ownership. Redi-box offers moving transport services for businesses and consumers, the service includes plastic boxes which are rented out to the customer. Redi-box delivers the boxes at one location and further recollects them at the new moved location, the price is fixed, and transportation of the empty boxes are included independently of where you live within a specific area. The boxes are made from 100 percent recycle plastics and damaged boxes are recycled and used for reproduction in a closed-loop SC. The SC benefits of owning the products, which lies within the enabler of recycling and keeping the plastic value internally and the awareness of materials. Since new products are made from the same material as the old, recycling is smooth thus no clear knowledge within plastic recycling and bills of materials. The boxes are not repairable due to its low material value and the possibility to recycle after use. The lifetime is not planned; however, one box is proven to last for over 400 moves and different users. The drawback of owning all moving boxes, is the need for local material handling and storage with high tied up capital. The tied-up capital in form of plastic boxes is less off an issue due to the low value and cheap manufacturing costs.

2.4 Plastic Materials

The fundamental knowledge of plastics will provide the reader an understanding of limitations and possibilities with plastic materials. This section will provide the reader with essential knowledge about plastic materials to understand barriers and enablers within the scope of the paper.

It is easy to believe that plastic is a simple material that is either hard or soft. However, plastics comprise a large family of materials that can be classified into various types (PlasticsEurope, 2018; Naturskyddsföreningen, 2018). Apart from the different types of plastics it is also possible to add different additives to get the desired characteristics (ibid.). This makes plastic a complicated material to take care of after usage without any form of traceability and knowledge of containing materials. It is shown in figure 5 how different qualities of plastic waste can give different outputs. Recycling of mixed plastic waste demand sorting, collection and reprocessing which is costly and recycled mixed plastic waste also gives low quality (Nationalencyklopedin, 2018). The low quality of recycled mixed plastic waste limit areas of use to products with larger error margins such as noise reduction walls, traffic cones etcetera. Therefore, it is important to know the included materials in order to reduce the number of activities necessary to separate a product into singular materials.

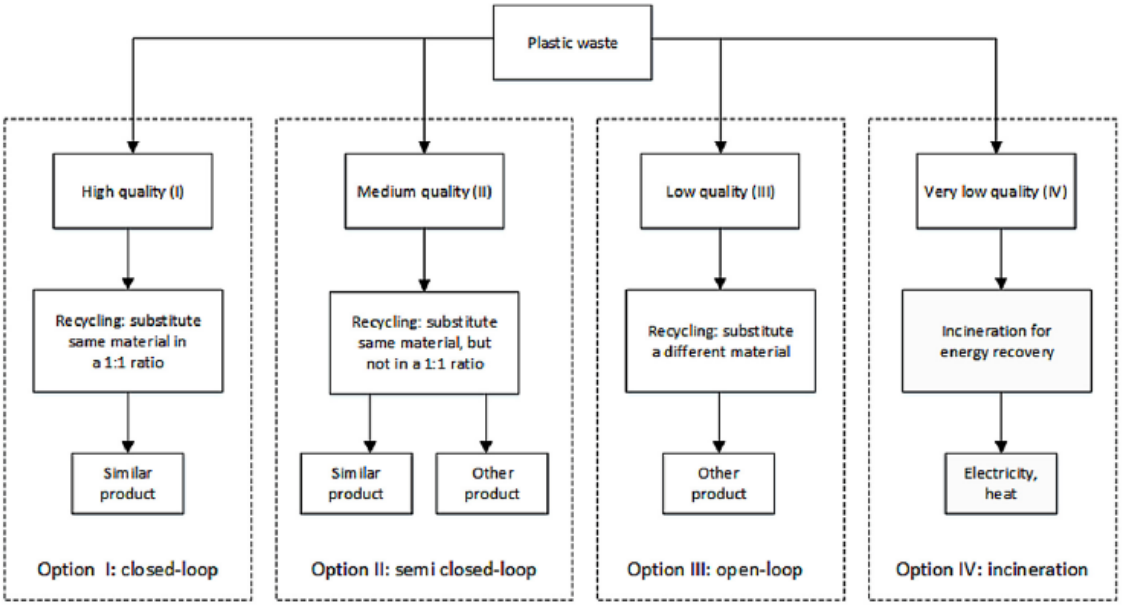

Figure 5: Different waste treatment options. Huysman et al. (2017)

In the Swedish market on average only 13 percent of the plastic value is preserved (Eklund et al., 2015). This shows the potential of value recovery if measures are taken at an early stage to plan for as much value recovery as possible after usage of the product. The price of virgin plastic varies between 9 SEK to 40 SEK per kilogram where the average across all sorts of plastic is 20 SEK per kilogram (Eklund et al., 2015). In terms of production, plastic has passed steal when it comes to volume and the world-wide

production of plastics is currently around 350 million tons (Nationalencyklopedin, 2018). Although plastics exist in different types, all of them have a low density (Nationalencyklopedin, 2018). This creates the challenge of getting high weights during transportation. However, it also means that plastic products are light and easy to handle manually (ibid.).

2.5 Analysis model

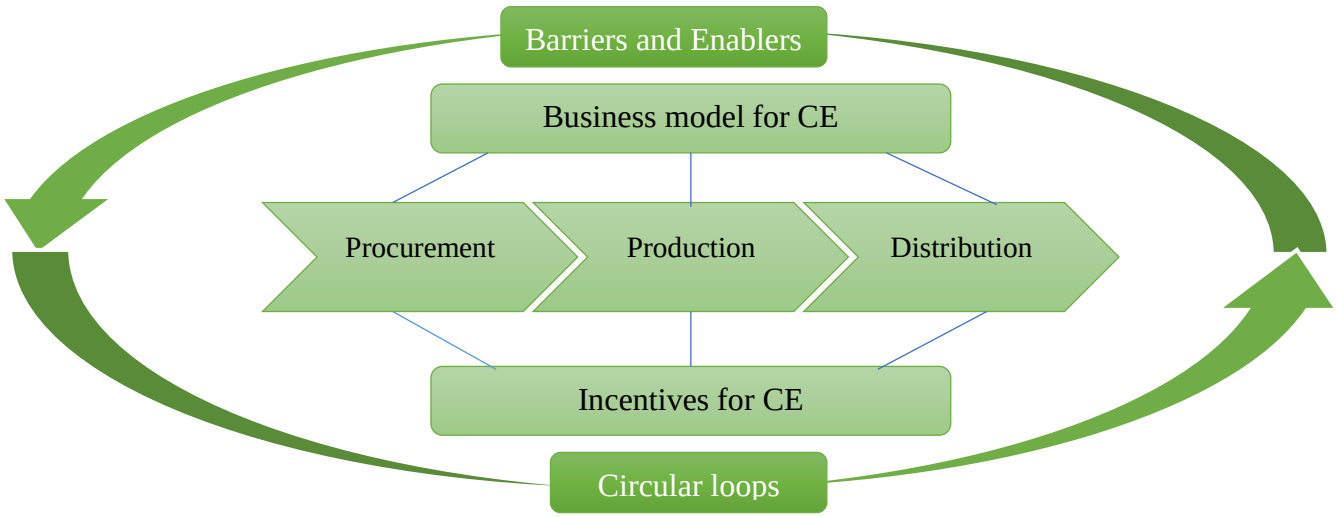

Figure 6: Analysis Model

CE is truly waved together with SCM and based on the theoretical framework, an analytical model has been developed. The analysis model is designed for visual and practical use and guidance when combining SCM and CE. The model consists of three core SC activities (Procurement, Production, Distribution) which are adapted based on the purpose and scope of the paper. The activities are of circular characteristics and are highly dependent on the base of the model, "Incentives for CE" parallel with the core of "Business model for CE". When the SC activities reaches its ending, materials or products must return and rely highly on the elements of Enablers and Barriers and Ciruclar loops. These two elements have been defined in relation with the sections of "2.3 Successful Circular Loops" and "2.4 Plastic Materials". The analysis model will be used for further analysis and applied on Case A and Case B for results which aims at the study´s research questions. The terminology can be found below, and the analysis model can be seen in Figure 6:

Business model for CE act as the core SCM factor of each SC activity. If SC activities are independent of a business model, the results will not be desirable. Business models requires unique characteristics for its purpose and goals, however the core and crucial aspect is the coordination with its related SC activities.

Incentives for CE act as the base for each SC activity, if there is no genuine reason or incentive for an action in a SC, the output will not be desirable.

Procurement is a pre-consumer activity within a SC which involves e.g. term agreements, contracting, purchasing of goods or services.

Production is a pre-consumer activity within a SC which involves e.g. design and manufacturing.

Distribution is an activity within a SC which involves e.g. business model, transport solutions, ownership transaction.

Circular loops are activities within a CE SC which involves e.g. Reuse, Remanufacturing, Recycling (RRR) of products or materials and recollection methods for these.

Barriers and Enablers are of interest for a successful circular loop activity and to understand what is required for it.

3 Methodology

The methodology describes how the study has been conducted and provides the reader with the reasoning from the authors behind the included parts and the methods chosen. Ending with reasoning for the trustworthiness of the study.

3.1 Research approach and design

During this study the theoretical framework has acted both as a tool for analysis of the empirical findings and has contributed directly to the analysis and conclusion. Further, the empirical findings have not only been the foundation of analysis, but also contributed with input to improve the analysis. So, to answer the research questions of this study there was a need for a flexible research approach. According to Bryman & Bell (2015), there are three different research approaches; deductive, inductive and abductive. Deductive research aims to confirm or reject a hypothesis by combining theoretical and empirical findings. Inductive research is done when generating new theory and abductive research is a mix of the previous two. An abductive approach means that there is a constant relation between the theoretical and empirical results throughout the study, as displayed in figure 7 (Dubois & Gadde, 2002). This was in line with the approach necessary for this kind of study, as both theoretical and empirical findings, separately and together, contributed to the conclusions of the study.

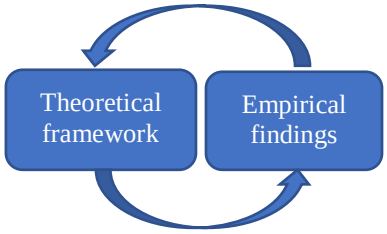

Figure 7: An illustration of abductive research

Before choosing a research design it is important to know if the study will include statistical analysis or information that can only be gathered through interviews, observations etcetera (Bryman & Bell, 2015). Depending on the study one can have a qualitative or a quantitative approach (ibid.). A quantitative study is characterised using numbers as data, which excludes the room for interpretation of the data. A qualitative study is focused on words rather than numbers, which create the need of verifying the data, since it leaves room for interpretation. Since the empirical data collection of this study was based on interviews and observation it was a qualitative study.

3.2 Structure and motivation of the study

This study has been part of a larger project “Cirkulera Mera”, which is owned by Chalmers Industriteknik and sponsored by Re:Source. Cirkulera Mera is a project involving various actors working with designing and developing products, distributing products, handling products after consumption and representatives from various universities. The representatives from the universities were both researchers and two other pairs of students performing their thesis within construction waste and electronic waste. Chalmers Industriteknik is a foundation created by Chalmers University of

Technology that works with commercial R&D, linking the university and companies. Re:Source is the leading research and innovation investment organization in Sweden. The purpose of Cirkulera Mera is that for household- and company waste create a long-term platform to generate knowledge about the impact of SCM on CE and suggest activities that allows effective circulation of products. It is from this purpose this study is created with the goal to contribute with conclusions to the larger project.

3.2.1 Organization of the study

As displayed in figure 8 this study was divided into five different phases. Before the study started, there were input from the Cirkulera Mera-project that the study should have a focus on plastic waste. Since it was a hot and interesting topic, made a good dispersion between the three treatises and representants from Essity, who works with plastic products, were included in the project group.

Phase 1:

Once it was decided that the focus should be plastic products, the authors started a background search of the topic to get a better understanding. This was an unstructured process with the purpose of getting as much information as possible since the authors had limited knowledge within CE before the study. Since the authors had substantial knowledge within SCM before the study it was further necessary to decrease the knowledge gap to find a suitable combination of the two topics to study. The background search included broad search terms such as; “Circular Economy”, “Plastic waste”, “Plastic recycling”, “Plastic” etcetera. When the authors had more information about the current situation regarding plastic in a CE, a setup for the specific study was decided.

Phase 2:

Essity was included in the Cirkulera Mera-project and was therefore a natural partner for this study. However, the authors agreed that it was not possible to make such a detailed study so just one company was enough to cover the scope. Therefore, it was necessary to decide how many more companies that should be included and who it should be. To get another angel of the problems within CE it was decided that a producer should be included in the study as well, the company was Nolato. This allowed for analysis of the challenges and enablers regarding both pre- and post-consumer waste. Further, with only two case companies, it allowed the level of detail to an extent that the results became interesting for the case companies and at the same time suited the scope of the study. With pre-consumer waste the material was clean, and the company had knowledge of the plastic content of each product. However, handling the production waste was not part of the core business and therefore unusable products and production waste just got burnt. While handling post-consumer waste it is not certain that labels explaining material content is still readable when it is time to handle the waste. The material has possibly also become dirty and must be cleaned before further actions can be taken. Further, it can be assumed that post-consumer waste is of much larger quantity than pre-consumer waste. Post-consumer waste usually gets more attention in media, especially plastic waste in the ocean. So, both cases had their challenges and possibilities.

During the early stages of the project it was also decided that including a recycler would have a major positive impact on the study. This gave primary real-life information of the barriers and enablers of plastic recycling instead of secondary information from literature. Including a recycler also gave the possibilities to include primary information for calculations of possible savings or earnings by moving towards a CE. Further, it gave the authors additional insight about the plastic industry in reality and not just on paper. Once it was decided that two case companies and one recycler should be included in the study, it moved into phase 3.

Phase 3:
Once the setup of the study was decided, necessary data needed to be collected, which is described more in detailed in chapter 3.3. To gather the empirical data, that could not be found in secondary sources, it was necessary to include interviews within the project. Due to the qualitative approach of the study, interviews were needed. The study did not take place at any of the case companies, therefore all interviews also included a site visit with observations to get an even better understanding of the discussed topic and the plastic industry in general. The site visits were done before the interview allowing the authors to come up with more questions that were not thought of when the information about the site was missing. Later, during the writing process all information specific to each company were sent back for confirmation so the authors interpreted everything correctly. The persons that were interviewed were the ones with most knowledge within product development and distribution for post-consumer waste, and about the production and procurement, for pre-consumer waste. There was also a previously established contact to these persons. To get the best possible information all questions that could not be answered directly were either checked with colleagues of the interviewee or collected from statistics at a later stage.

The literature that were collected had three different purposes. To provide the reader and the authors with information that were needed to understand every aspect of the topics. To contribute directly by answering parts of the research questions. To create a theoretical foundation necessary to analyse the empirical findings.

Phase 4:
Combining the empirical findings and the theoretical framework an analysis was done. This part was done to handle different aspects of the topic of the study and lead up to the conclusion. The analysis was based around the model presented in chapter 2.5. This structure was chosen to give the reader a visual display of the authors thoughts and thereby easier follow the report. Further, the structure displays a situation where the case companies are represented in middle as a SC and the surrounding shows the different parts to analyse.

Phase 5:

The purpose of the conclusion was to provide a relatively short and concise answer to the research questions. This section aims to grasp the most essential parts of the analysis. Further, it included a discussion where the problems presented in chapter 1.1 were discussed. This chapter allowed the authors to freely display their thoughts of how the results of the study could by applicated in a larger context.

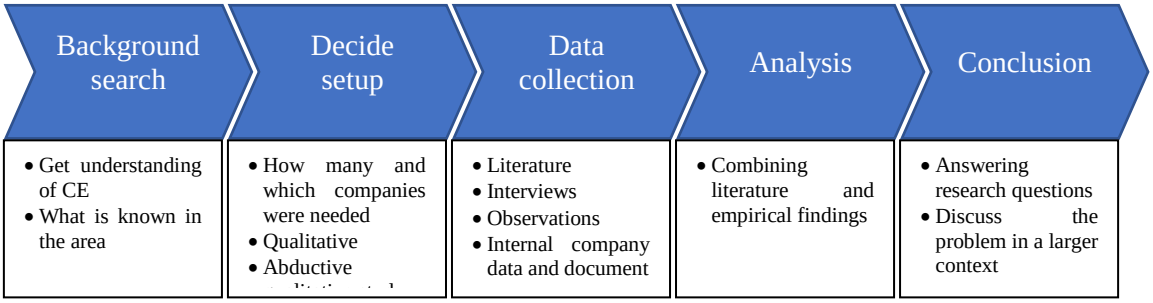

Figure 8:The conducted stages of this study

3.3 Data collection

Enabling specific results in a research requires relevant, reliable and enough quantity of information (Patel & Davidsson, 2011). The authors refer to information as data in various forms and the collection depends on which method results the best conclusions towards the research questions of the study and available time and resources. Eliasson (2013) identifies two types of data, primary- and secondary data.

Primary data were found within information which the authors collect for further analysis in terms of; interviews, observations, company data or pricing.

Secondary data were found within the information which is procured through literature studies like; books, scientific researches, conferences, or other sources. This information is often studied and applied for other purposes than the intention of this study made by the authors (Björklund & Paulsson (2012). Since the purpose of secondary data is generated for other purposes, the importance in analysis requires an objective awareness since the data possibly is angled and will not be suited for every new study (Goode et al., 2017).

The data collection section will include primary- and secondary data collection methods which were applied for the study. These will give the reader a deeper understanding of precise data collection methods and its characteristics of purpose and difficulties.

3.3.1 Literature study

Collecting secondary data within the authors research approach is an important step towards knowledge increasement and founding a base for both reader and author (Bryman & Bell 2003). The approach of collecting literature is through physical fundamental scientific books and articles with a combination of digital platforms for simplicity and

efficiency purposes. The digital platforms used by the authors are large databases like Chalmers Library, Google Scholar and Mendeley.

To ensure quality and correct definitions of core subjects, the authors have chosen older and fundamental values of each definition and further added more updated definitions upon these. Core definitions and keywords within the study where "Supply Chain Management", "Circular Economy" and "Plastic material characteristics". The keywords generated new subjects from the core topics, SCM included keywords as; Business model, Coordination, Planning, Value/Surplus, Logisitcs and CE included keywords as; Reuse, Remanufacture, Recycle, Product Service Systems, Corporate Social Responsibility and Plastics included keywords as; Material Value, Material Characteristics and Material Recycling.

The topic of CE and SCM combined is relatively new, the authors entered an undeveloped field, hence, the importance of clear and objective definitions of the core values CE and SCM. Bryman & Bell (2003) define the importance of the theoretical base as mutually important for reader and authors hence the exploration possibilities for both within the area. The large and niched foundation has provided the authors with knowledge and structure in the core values of CE and SCM within plastic materials. The foundation and detained data from the "Cirkulera Mera" project, Resource reports and European Commission reports increased confident and certainty for analysis and discussion, which lead towards the findings of the research questions.

3.3.2 Interviews and observations

The collection of primary- and secondary data is structured by the authors regarding three phases, pre-interview, interview, and post-interview activities. O´Gorman & MacIntosh (2015) identified these phases as important for interview conduction and the authors decided to procced with similar structure.

Pre-interview phase required a sophisticated understanding of who the interviewee was and what background he or she had. Structuring the questions and layout will in the future help achieve the goals and results of the interviews. Even-though O´Gorman & MacIntosh (2015) prefer a less structured strategy for face to face interviews, the authors created a template with structured question suited for the interviewee and represented company. The interviewees position and role are of great importance when designing and formulating the questions, which the authors kept in mind and carefully chose interviewees based on academic preferences. These preferences were the actual knowledge within the area and professional background. The structure of interview questions was adapted for each case and interviewee; however, the principal and core were the same. The purpose of each interview was to visualize and understand their current SC, therefore the questions were structured to simulate and recapture the flow. In order to maximize the output, within each topic and question, space for the respondents' own comments and ideas were left. This generated space and fluidity in the interview and the authors observed carefully these genuine comments and responses. Before each

interview, the authors received information about available time and based on this information created a proposal for maximum usage of time. The first interviews with the companies were focused on explaining the project and finding a mutual interest, the authors prepared a presentation with goals and purpose of the study while explaining for the company what their role will be and what the expected performance and requirements will be. After approval new interviews were planned, these were suggested to include short a company presentation, a site visit and finally, the premade questions. These questions followed a specific structure as mentioned earlier and were always sent to the interviewee in advance for possible preparation.

Interviews were all planned to last between 2-3 hours in total for each visit, since the questions were sent in advance all questions were answered, even though some questions were out of the respondent's area. The space in-between each question gave crucial "behind the scene" information which also resulted into quotes within the empirical findings. Relaxed and structured interviews with space for general talk characterizes as a semi-structured interview style in the interview phase (Bryman & Bell, 2003). During each interview a tour of the facility was held for the authors with generous time for careful observations and questions during the round tour. Pictures were allowed in specific areas for memory and understanding. All interviews were recorded parallel with one of the two authors who took notes. The interviews and observations during the study are summarized in table 2 below:

Table 2: Interviews and observations done for the study.

Activity (Interview or Observation)	Company, Interviewee, Position	Comments	Date
Interview	Chalmers IndustriTeknik, Linea Kjellsdotter Ivert, PhD Project Leader	Introduction of the project and problem description.	11/01 – 18
Observation	CIT – Cirkulera Mera	Kick-off	26/01 - 18
Interview	Nolato Gota, Martin Svensson Randsalu, Business Development Manager	Introduction for the case company and suggestion for involvement.	27/02 - 18
Interview	Essity, Robert Kling, Innovation Manager	Introduction for the case company and suggestion for involvement.	01/03 - 18
Observation	Axjo, Anders Gaardsdal, COO	Observation of plastic recycling and production facility.	02/03 - 18

Interview and Observations	Nolato Gota, Martin Svensson Randsalu, Business Development Manager	Semi-structured interview and facility tour.	07/03 - 18
Observation	PLAN, Seminar	Seminars about CE and SCM for efficient circular flows.	22/03 - 18
Interview and Observation	Essity, Robert Kling, Innovation Manager	Semi-structured interview and facility tour.	04/04 - 18
Interview and Observation	Veolia, Jesper Sundhall, Purchase/Sales Manager	Semi-structured interview and facility tour.	20/04 - 18
Interview	Anna Ohlsson, Stena Recycling, Site Manager.	Phone interview.	09/05 - 18

Post-interview phases included summaries and transcriptions of the held interviews, after the results were collected and analysed, missing, and complementing answers were addressed. A relaxed and informal relationship with the partners enabled good mail and phone communication and many questions were answered through digital platforms. This unstructured method enabled flexibility and overlapped the pre-interview and interview phases with complementary inputs. The downside with this method is time management, however the precise and well thought answers gave the authors exactly what they required.

3.3.3 Internal company data and documents

Preserving case company secrets and not leaking sensitive information required specific contracts between authors, supervisor, and the company. All collected data is either manipulated with a factor or, if not damaging the company, presented in its original form. The factors will not affect the output or problem in any way, all fundamental problems and data is presented in an objective way. The report is carefully examined for accuracy and safety by the company in advance before publication was done. Collected data included waste management costs, production quantity, production waste quantity, raw material price, sale price, recycling price and bills of materials.

In Case B, a generalization was created of included materials, the authors combined in chapter 4.2.1, the three products' material specifications and took the average numbers to create a fictitious product, which represented all the three in an objective manner. The reason for proceeding in this way, were the close similarities of included product materials.

3.4 Trustworthiness

Quality, a measure which is determined by the user or consumer, *trustworthiness* is one measure of a report´s qualitative quality. Trustworthiness is a combination of quality measurements of Credibility, Transferability, Dependability, and Confirmability (Erlandson et al., 1993).

3.4.1 Credibility

Truth-value as credibility relates to internal validity, the concept of credibility is based on the study´s quality and by the degree of systematic error minimization (Halldórsson & Aastrup, 2003). Achieving a credible study favours that no single objective reality exists, interviewees represents the reality and their mind and control positions them in a dependent role. Decentralizing the interviewees role of constructing a falsification or vague reality picture is crucial when increasing the credible truth-value Erlandson et al. (1993). The authors chose respondents with care and structured the questions in qualitative and quantitative forms. Sensitive and crucial data for credibility was structured and collected in a quantitative manner, the underlying reasons, and decisions off less importance for the actual problem and result were collected as qualitative data. Cases of the study was chosen with mutual interest between partners and authors while related to an objective global issue, plastic disposal. The respondents and the authors shared similar views of the issues and worked jointly in individual powers towards the final result of the study. By identifying and agreeing on actual issues, which were strengthen by quantitative data and facts, reduced the single objective reality, and widen the scope and perspective of the problem.

3.4.2 Transferability

Transferability applies for the study´s level of ability to make general claims about the surrounding. Generalization is not the definite goal of the qualitative study; the goal founds within the provided detail content for receivers of the study. The study enables the reader to lead decisions to the extent the findings may be relevant and applied for the environment one represents (Cowan, 2012). The study was based and constructed around two case companies and a recycler which represented a complete SC. The results were addressed towards each specific case issues, thus, the SC case representation, suggested methods, and results, enables transferability towards receivers of similar and diverse needs. Global plastic disposal issues have been addressed on higher national level as a global issue, the recognition of the fundamental plastic disposal problem is well adapted in the market and aware is high of the issue described in the introduction by the authors. The objective SC generalization and combined with the global issue of plastic disposal enables a high transferability towards various receivers.

3.4.3 Dependability

Dependability adds consistency and reliability to the result, if one did the same study over again, will same result be achieved? The dimension concerns data stability and dependency over time and is achieved by clear structural documentation. A logical and

clear processes with necessary decisions and methods are required to be outlined in the study for replication purposes (Guba & Lincon, 1989). Barriers and enablers within a SC towards a CE is a relatively new concept and the understanding and availability of data is restricted due to current subject maturity. If the study would be reperformed in current environment with same subject maturity and issues, the study would be considered as highly reliable and valid for replication. Thus, in any future state, replication would not be possible due to development within the topic of CE and SCM combined.

3.4.4 Confirmability

The dimension of confirmability conceptualizes the view on study´s objectivity, the findings must represent the results and not the authoress's biases (Halldórsson & Aastrup, 2003). The findings are based upon highly reliable theoretical frameworks, firstly analysis is performed with fundamental aspects of the theory mixed with the empirical findings. The analysis compares the current SC case processes with ideal flows of a specific CE flow. Further discussions with primary data and underlying causes will be addressed for specific reliable findings. The findings were confirmed and tracked back by external and internal audits for high confirmability, the audit were experienced researches and professors from Chalmers University of Technology. The tracking resulted into reliable and confirmed sources which found the conclusion and findings.

4 Empirical Findings

The following section will describe the two cases, followed by an expert interview with a procurement manager at a recycling company.

4.1 Case company A – Producer

Nolato is a producer that represents the handling of pre-consumer waste in a CE and is connected to procurement and production in the analysis model presented in 2.5. This case will display barriers and be the foundation for finding enablers involved in pre-consumer waste. Therefore, three different case products were chosen in collaboration with the case company to get graspable objects to work with.

4.1.1 Company and Product description

Nolato is a producer and developer of plastic products for a wide range of different application areas. By involving both development and production they can provide customer unique solutions. They were originally founded in Sweden and have now a global presence with multiple sites in three different continents. Further, the company works within three industry sectors; medicinal aid, components in telecom and products for industrial companies. All these sectors create pressure to provide products of high quality. The company can be found on the mid-cap of the Swedish stock market and they had a turnover just below 7 billion SEK in 2017.

The three chosen products are called *plenum, oil pipes and cappings.* These were chosen due to a relatively high product value, large volumes and high customer demands in terms of quality. In table 3 the weight, sales price, sales volume and total sales value per year is displayed. Common for all three products is that they are used in cars and created in almost only plastic. With a brand-new car being such an expensive product, customers demand nothing less than perfection. This creates a challenge where even the slightest defect can result in an unusable product and thereby losses for Nolato. Currently defect products are used for energy recover by combustion. However, the company is keen to firstly reduce the number of defect products and secondly find a solution of better use for defect products. Both for monetary reasons as they must pay to get rid of unusable products and to reduce the environmental footprint.

Table 3:General information about the three case products from Nolato

Product	**Weight (g)**	**Sales price (SEK)**	**Sales volume (pieces)**	**Total sales (SEK)**	**Material components**
Plenum	1,500	20	50,000	1,000,000	1
Oil pipes	75	2	120,000	240,000	1
Cappings	300	5	20,000	100,000	4

The plenum act as a connection between the front windshield, the wipers and the front part of the car. It is produced from a single plastic material with an additive and some

metal rings are added to avoid cracks in the plastic during attachment to the car. As seen in table 3 plenum is both the most expensive product and the one with most sales value.

The oil pipes are situated inside the car with the assignment to transport oil. Therefore, it is exposed to a large amount of heat. The oil pipes are produced from a single plastic material with an additive comprises the entire product. Further, the oil pipes stand for the largest amount of sales in terms of volume.

The cappings is the most advanced product in terms of material components. They consist of two components, each created by two different kinds of plastic, resulting in four different plastics. The cappings has also extremely high demands on surface finish, where defects can be difficult to detect for someone inexperienced. So even though it does not have the highest sales it still contributes to the number of combusted products.

4.1.2 Supply Chain Case A

Figure 9 shows what happen to the pre-consumer waste within the production of company A and how products that do not meet the requirements are handled. During the entire process, company A owns the product and they have full knowledge of the material components that is inside every product. The production starts with company A receives plastic pellets from suppliers that are stored before it enters production. The material can be stored in a silo, metal container or plastic bags depending on if the material is a high-runner or not. Before material can enter the production, it must go through heat drying to remove all moisture to get a smooth moulding process with the right characteristics of the raw material. The moulding can both be the only process necessary to create a product and be used to create components. However, moulding is the only process through which products are created. After the product or component has been moulded it goes through a manual quality check with high demands.

If the quality is satisfactory the components are assembled together before the end product is stored for further transportation to the customer. Products without the need for assembly go straight to storage. If the quality is not satisfactory the product usually ends up in a bin which is later sent to a recycler for energy recovery through combustion. The dotted arrow represents that in extremely few cases, products that do not meet the quality requirements enter a small shredder next to the machine and goes straight back into the material system. However, as presented by the interviewee, “these shredders produce a lot of noise that could be harmful if workers are exposed during a period without additional ear protection”. For the shredders to work, the product must also be of a single material.

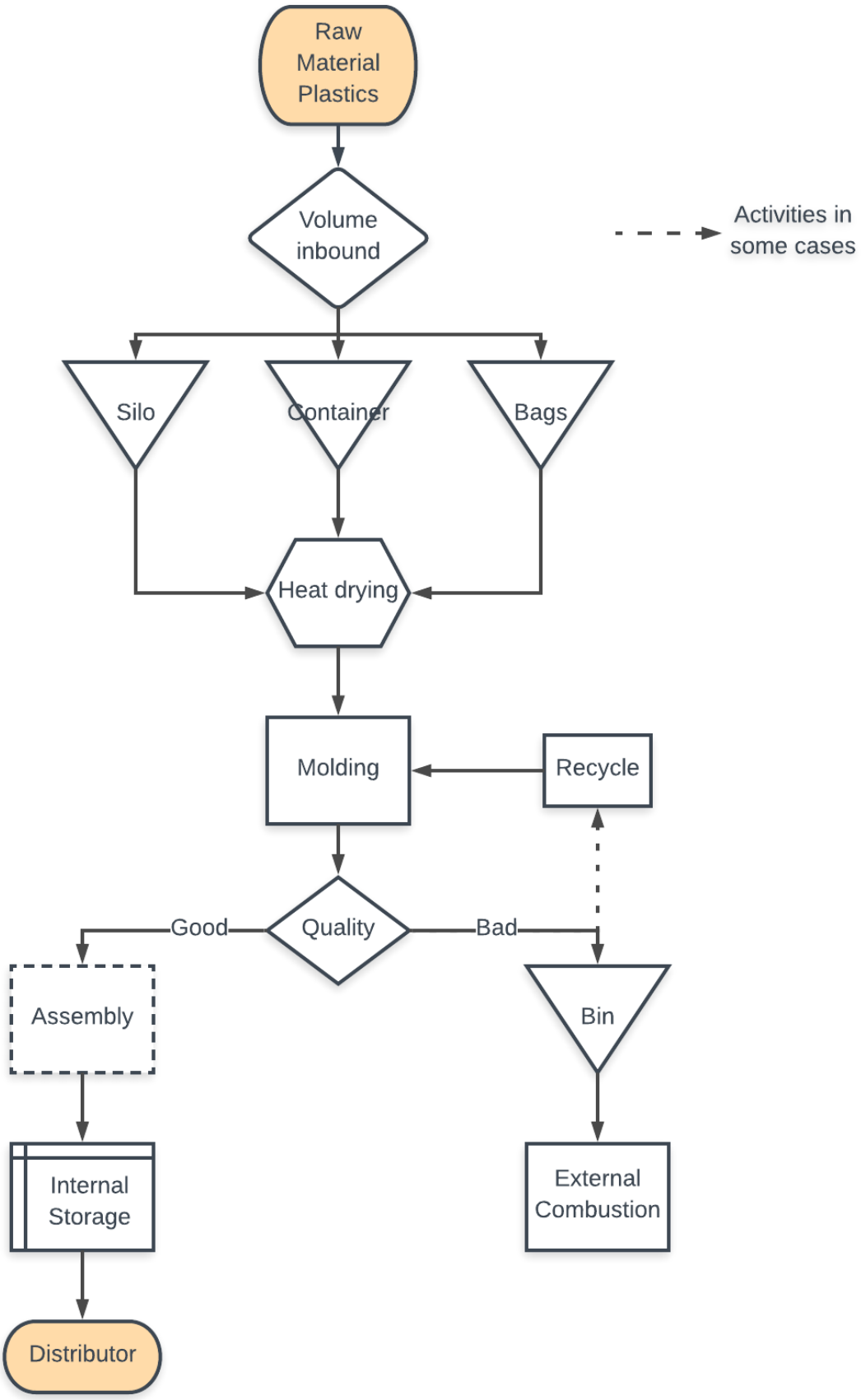

Figure 9: Supply Chain Flow - Case A

4.1.2.1 Procurement

The procurement of Nolato is focused around the customer and the different materials Nolato purchase depends on the material that the customer wants in their product. However, Nolato always recommend materials and suppliers that they currently use to be able to purchase large volumes, from few suppliers and reduce the varieties of materials. This results in four materials constituting of 90 percent of the yearly purchased volume. Within the varieties of material, they purchase less than 5 percent recycled plastic. The prices of the raw material necessary to create each of the three case products can be found in table 4.

Table 4:The price of raw material for the case products

Product	**Purchase price in raw material (SEK)**
Plenum	5.1
Oil pipes	0.625
Cappings	1.941

Once the customer requirements are fulfilled, Nolato focus on low price, high delivery precision, low environmental impact and high quality in a declining order of importance. Since Nolato works so close with their customers they also seek collaborative long-term relationships with suppliers to be able to secure the materials requested by the customers. To exemplify, they state this in their supplier requirements: “Supplier development and professional collaboration throughout the chain is positive for all involved”. Further, they also have the high expectations on their suppliers that their customers have on them. These expectations are exemplified by both specific ISO certifications and abstract values as safety, quality and environmental engagement.

Nolato also demand 100 percent delivery precision and that deliveries should be on time, in the right quantity, with right quality to the lowest cost. It is also stated that cost has a high priority. Low cost could be considered an order winner as there are other factors that are expected to be fulfilled before a price comparison is done. Further, they emphasize a lot that their suppliers should have a management system for working environment and take environmental responsibility. Once a relationship is established, Nolato also has regular check-ups that the suppliers continue to meet the requirements.

4.1.2.2 Production

Since Nolato’s products have high quality demands it is difficult for them to include any recycled material without compromising the quality. Due to the high-quality demands, both from customers and internally, there are also a lot of unusable products that adds up to substantial costs every year for Nolato (see table 5). Even though the number of unusable products varies between product categories, an average throughout all products have been used for an easier understanding. Nolato both lose the revenue of not selling the unusable product and must also pay to get rid of this product. In total, on average, around 13 percent of the purchased materials end up in combustion, resulting in

substantial losses. Although it costs to get rid of the products it is the value losses that have a massive impact.

$$Value\ Losses = Sales\ value\ of\ a\ product * Percentage\ of\ unusable\ products$$

The cost of getting rid of *plenum* (figure 10) each year is 6,680 SEK and plenum contributes to 6.5 percent of the total costs of material disposal. That is due to it is a relatively heavy product for being made in only plastic. Since it is a high value product, the value losses for combusting plenum is 97 times larger than the cost of material disposal. Apart from being a heavy product it is also quite bulky, which creates difficulties of getting full truckloads. Therefore, it is favourable to turn the products into smaller pieces before transportation to get as full load as possible.

Figure 10: Picture of Plenum.

The *oil pipe* (figure 11) is a much smaller product and does not have the same problem with full truckloads. However, during the production there is constant waste of 100 gram per every two products, excluding the products that do not meet the requirements. The oil pipes are produced from one larger pipe that is cut into two pipes and from this process waste is created due to small pieces that is not included in the final product. This waste combined with unusable products is 4,911 SEK, which contributes to 4.75 percent of the total cost for material disposal. The value losses of the unusable products alone are 31 times larger than the cost of combusting both unusable products and the production waste.

Figure 11: Picture of Oil Pipe

The *cappings* is the product that has the highest quality demands (see figure 12) and therefore they contribute largely to the number of unusable products. When it comes to transportation they are long and flat and therefore rather easy to reach a large truck load. However, the product consists of two different components and they are difficult to separate manually. Regarding the costs of getting rid of the waste it is relatively small for the cappings and they contribute to 0.5 percent of the total cost of material disposal. But the value losses for non-sold products are much larger at 121 times compared to the cost of material disposal.

Figure 12: Picture of Capping

Table 5: Figures connected to combustion of the three case products

Product	Yearly material disposal (kg)	Cost of material disposal (SEK)	Value losses (SEK)
Plenum	9,750	6,680	650,000
Oil pipes	7,170	4,911	156,000
Cappings	780	534	65,000

4.2 Case company B – Distributor

Essity's empirical data covers post-consumer SC activities with focus on distribution and circular loops from the analysis model developed in chapter 2.5. The empirical data will provide an essential understanding of the company´s SC and the current barriers of working towards a CE. In collaboration with the case company, a product group is mutually chosen for analysis throughout their SC and post consumption.

4.2.1 Company and Product description

Essity is a global stock listed company on Nasdaq Stockholm within the hygiene and health sector who are dedicated to advance well-being through provided products and solutions for everyday life. The global expansion reaches 150 countries with their major brands, such as TENA, Tork, Libero, Libresse etc. The total employment is around 48,000 and Essity amounted in 2017 sales up to 109 billion SEK. This paper focuses on the brand Tork and its plastic dispensers for bathroom purposes within the Elevation series.

The Tork Elevation assortment includes dispensers for paper tissues, toilet paper, soap and some options for garbage bins, all these are suited mainly for official purposes and not private consumption. Typical allocation for the Elevation assortment is at public areas like schools, offices, airports and many more. The product line has different tones of its main colour, transparent and solid, however they are unicoloured with two options for the buyer, black or white. Their most popular products among the Elevation assortment (Year 2017) are:

- Art: H1 for tissues on roll, can be seen to the left in figure 13.
- Art: S1 for soap, can be seen in the middle in figure 13.
- Art: S4 for foam soap, can be seen to the right in figure 13.

The Elevation product line is mainly manufactured in plastics with minor metal details. All materials shown in table 6 are not used in every product, a detailed explanation of the general material division can be found in the methodology chapter 3.3.3. Table 7 and table 8 presents annual costs and total weighs. The general material content division for the fictitious product is described in table 6:

Table 6: Average material content division for Tork Elevation assortment.

Plastics:	
ABS (incl. MABS)	86.97 %
POM	2.77 %
PA	0.74 %
PA + GF	1.68 %
PC	0.70 %
PC/ABS	1.78 %
TPE	0.23 %
Metals:	
Copper	0.33 %
Aluminium	0.34 %
Steel + Stainless Steel	4.06 %
Others:	
Sandpaper	0.08 %
PCB (Used in chips)	0.33 %

Table 7: Average costs for the fictitious product.

The total average costs for the Tork Elevation assortment which are divided into manufacturing and logistic costs are following:	
Manufacturing costs of the total product value are:	
Raw materials (Plastics):	47 %
Raw materials (Non-plastics and packaging):	31%
Assembly and other:	22%
Logistic and warehousing costs of the total product value is:	6%

Table 8: The weight of the three sold products per year.

Annual sold weight of the three products are (kg):	
H1:	998,400 kg
S1:	119,730 kg
S4:	160,000 kg

The products are designed with a robust construction to last in harsh environment while being pleasant for the eye. Every product goes through careful durability tests and must fulfil internal quality and durability requirements for sales approval. The average product lasts a lifetime with normal usage until renovation or upgrade is desired from the customer. Essity designs and produces new family assortments every 8 to 10 years and the products have no planed life time. In some cases, the product lasts for over 15 years

with or without restoration. There are possibilities for customers to repair broken covers or other mechanical parts by ordering spare parts which are available through various channels. The products are transported to end customer completely assembled, and as mentioned earlier represents 6 percent of the total product value.

Figure 13: Pictures of (from the left) H1, S1 and S4

4.2.2 Supply Chain Case B

Figure 14 visualizes Essity´s current SC from manufacturer to post-consumer actions and their product ownership throughout the chain. The ownership is characterized by the ability of tracking and owning the product or service. The colour representations in the flow are clear out in the figure and various shapes in the flow has different meanings. The ellipse represents actors in the chain and those ellipses with colour are start or end actors in the current SC. The rhombus represents a decision that must be made within the chain and will affect the direction of flow in next coming activity. Triangles are warehouses or material merging point of any kind and the squares are formal explanations of external activities outside the SC. The first reverse flow appears in the first decision of design, Essity set requirements towards its manufacturer, if the requirements are thus not fulfilled the flow is returned until an approval of the design and requirements are set. After manufacturing with Essity requirements the finished products are sent to a central warehouse for further distribution to local warehouses, which is not necessarily owned by Essity. After the local warehouse the ownership changes depending on chosen distribution channel.

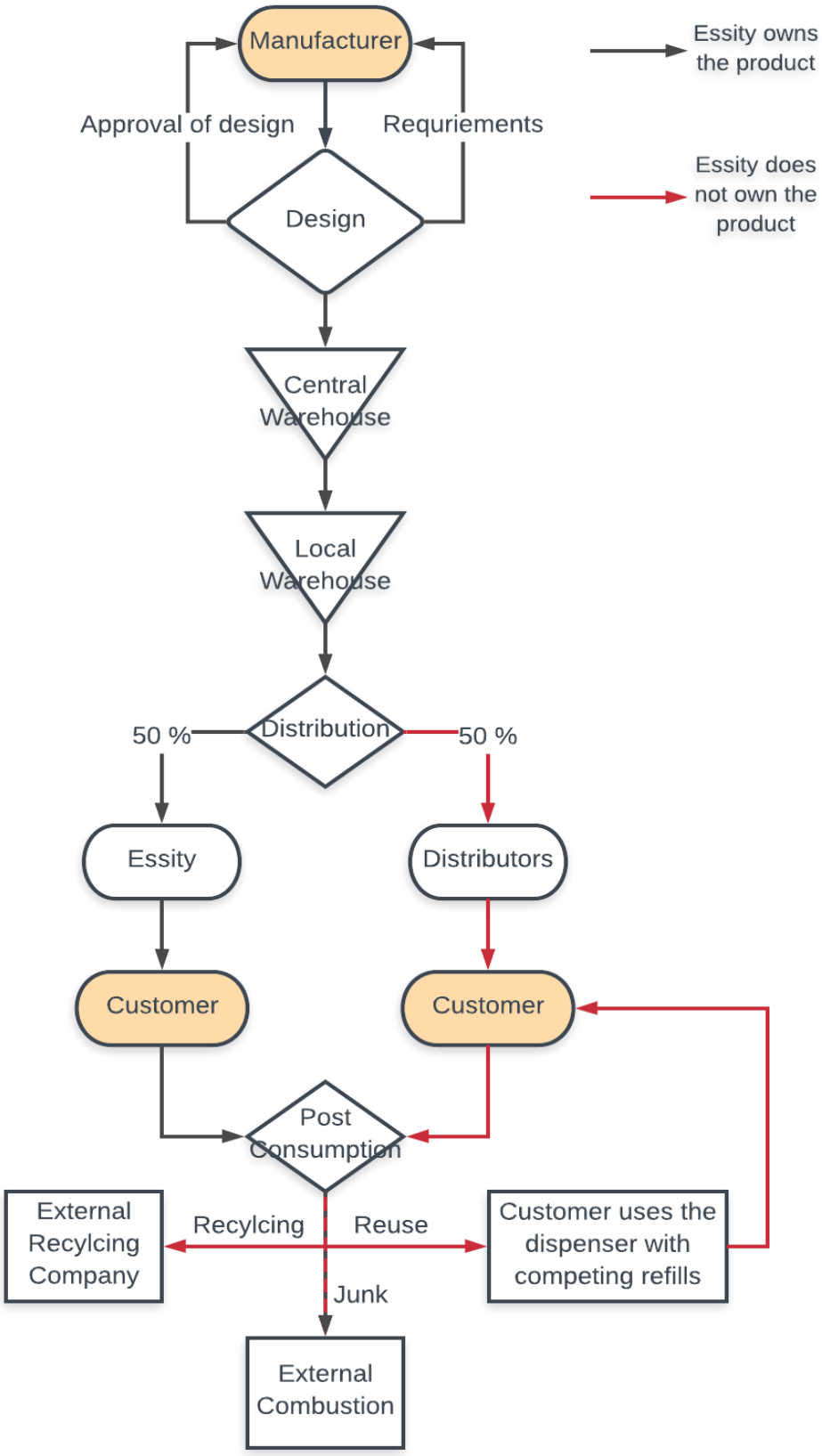

Figure 14: Supply Chain Flow - Case B

4.2.2.1 Distribution

One crucial decision which affects the flow is distribution, after products enter the local warehouse its path depends on the customer and its destiny. Larger customers are often distributed directly by Essity through their sales division while smaller customers find Essity´s products through distributors. There is no definite choice that Essity can make in any way, it's generally about contracting and simplicity for the customer. The customer size is not a factor of who should distribute the customer, it's a matter of availability for the customer and what the internal sales department can swap up from the market. In some cases, the consumers choice of distributor has its incentives in simplicity and they may have existing contracts with local distributors. The division of distribution channel is about 50 percent for each channel between distribution through Essity´s sale department and distribution through various distributors.

Essity Distribution

50 percent of Essity´s customers are supplied through direct contracts; the contracts are usually of 3 years length and 70 percent of existing customers renew and extends their relationship with Essity. Every customer is unique, and each contract is customized for each customer's needs. The contracts include complete solutions in many cases and provides the customer with refills for the dispensers. In these cases, the customer agrees on a long-term contract of supply. The actual dispensers are free for the customer and Essity compensate these costs with a higher price on the supply, as in our case refers to paper tissues and soap. The transportation with supply and dispensers from the local warehouse to end consumer is contracted with an external, if possible, local hauler. The installation is carried out by the customer, and it's their responsibility to decide locations and methods for the set-up. The ownership of dispensers is Essity´s throughout the contract and after the signed period the customer can decide if extension is an option. If the customer decides to diverge with the current contract and does not renew, the dispensers should be returned to Essity, however there are no procedures for this. At present the customers can use the dispenser with paper tissues or soap from competing companies, Essity perceives this as a possibility for marketing purposes since the total lifetime has been proven to extend upon 15 years. What happens to the product post contracted periods is unknown to Essity, in some cases they are torn down among renovation, in rare occasions the customer has returned the dispensers. However, since there's no clear return system and current business model does not apply for any recollection the returned product where burnt for energy recovery. In cases where reparation is needed does customers have the option of buying spare parts for its dispensers and repair them.

Local Distributor

Distributing through local distributors adds one more actor to the chain, sales department contracts distributors who wants to sell their products and handle the supply of paper tissues and soap. The contracts are individual and not binding in any terms, they work more as long relationships thus the continuous procurement activities in-between the distributor and Essity. The distributor can easily supply local schools, offices, and smaller

organizations with own contracts and it's up to the distributor to ensure profit and create contracts that fits all parties. The reason customers choose local distributors is due to the simplicity and consolidation with various supplies like office materials or consumables. The consolidation will in some cases allow haulers to consolidate and save money, occasionally distributors have their own transport logistics and have the benefit of providing customers by example complete facility solutions like hygiene and office products. The promotion and marketing are held by the distributors, which adds costs to possibly a current marketing platform. Warranties and reclaims are forwarded towards Essity thus the ownership of dispensers is off their possession. Distributors "buys" the product to further do business with local users, due to this structure Essity has no track of its dispenser's allocation. Tracking is possible however never done since no purpose has been addressed. No research has been performed of what happens to dispensers´ post consumption, the most observed and common method is collect it as scrap during renovation and use the scrap for energy recovery. Since the ownership no longer is at Essity´s possession, the handling of post consumption dispensers varies and it´s completely up to the user.

4.2.2.2 Circular Loops

Reuse of dispensers is a complex situation and is not motivated during any contract with distributors or Essity. Since the dispenser requires supply of various kind over a period, it is often bounded with a contract. Distributors have their own contracting methods and do sell dispensers separately from supply contracts and vice versa. The possibilities and current reuse of dispensers are when contracts reach its end and consumers chooses to get supply from competitors while still using the same dispenser. This flexibility of choices for supply and dispensers are mainly common in the local distribution channel. When customers renegotiate their contracts with Essity the options of reusing the dispenser is given or to renew the contract with new dispensers.

Remanufacturing is not currently performed by Essity. The reason to this is the dispensers´ low value in relation to the total profit from a customer. It is easier to forget about the issue following how to collect and remanufacture the products. One more argument is the power of the brand, Essity is highly meticulous regarding what's presented to the end consumer. Since dispensers are actively promoting the brand, new models are motivated for every customer, "We are very meticulous regarding our brand and how we display it towards consumers" (Kling, 2018). Remanufacturing old editions will according to Essity have a negative effect on the marketing success and brand.

Recycle dispensers is a rare and not considered action, the reason for this founds within the difficulties of recycling plastics. The time required for an external actor to sort and understand which materials are included in the dispenser over laps the effort and therefore not considered at all. It is impossible to follow the exact path since its external individuals with different backgrounds who handle the post-consumer activities. The dispenser includes various materials as seen in the earlier chapter, the material complexity of different plastics and metals disables regular individuals to perfectly sort everything out.

4.3 Interview – Plastic Recycler

The SC flow reaches its final processes at a recycling or combustion facility for any plastic material and the process of handling is highly dependent on correlated factors and can change drastically because of minor inherences. The enablers and barriers for a specific path of flow are referred as factors, and the material value changes depending on what flow the material takes. Materials obviously do not have the ability to choose for them self, therefore it is the consumers responsibility to prepare materials for a specific flow.

4.3.1 Supply Chain Plastic Recycler

The material flow advances into two main sources which opens out to different paths either from pre- or post-consumer material flows when products have reached its final user, either for example regarding quality or being outdated, the flow can be seen in figure 15. The reason of ending a products life is individual and can be further discussed if necessary or not. When the product or material has reached its end, for whatever the reason, it needs to be taken care of. The handling differs depending on factors like quality, traceability of materials, colour, size, material, purity and cleanness of the products or materials. In table 9 it is presented some rough prices of what recyclers are willing to pay for material included in this study going into and out from the facility. The price for PMMA-PC/ABS-TPV is unknown since there is not any notations of this material mixture being sold for recycling purposes (Sundhall, 2018).

Table 9: Information about the plastics in this study

Material	**Price: Seller to Recycler (SEK/kg)**	**Price: Recycler to Buyer (SEK/kg)**	**Market demand**
PP	0.5	1.1	High
PA6	0.8	1.6	Medium
PMMA-PC/ABS-TPV	Unknown	Unknown	None
ABS	3.5	6.5	High

Pre-Consumer materials´ first step for a recycler is to ensure what the end user has to offer and enable the user to collect its materials, it can also be a matter of collecting on your own for the recycler. The post-consumer offering has different value, the kind of material mainly sets the value and further adjusted by the factors. The recycler decides if it will be profitable for recycling and what the customer must pay or be paid for a well-balanced business. In terms of material value, the best practice and highest paid material is when the customer handles all activities in the SC. Each activity that is outsourced, in practical terms handled by the recycler, decreases the material value for the consumer. There must be a balance of what's achievable for the consumer and the total costs, since in most cases recycling is not the consumers core business. After the recycler and customer agrees on terms and conditions for the material handling, collection is enabled for the materials. If the sorting is done for combustion, some minor regulations needs to

be addressed of what is considerable as combustion materials and what is allowed to throw. If the customer and recycler agree on recycling, stricter regulations and conditions will be considered. The sorting needs to be precise and mixture of various materials will decrease the final value. The sorting will affect upcoming processes, e.g. if not sorted in size shredding will be considered to ensure unity in size for next process. Complex material mixtures require traceability for the recycler. If the material is unknown, recycling will be unfeasible and to ensure the quality of the recycled material, a bill of material is necessary.

Post-Consumer materials are diverse and almost impossible for the average person to sort within the different fractions. The commonly used sorting segmentation is by soft and hard plastics. Larger companies and municipalities enable sorting for the consumer, however the responsibility relies on the actual consumer for correct sorting. “The difficulties within sorting various plastic materials for the average consumers restricts or eliminates the possibilities of recycling” (Sundhall, 2018). After sorting, various logistic actors, depending on agreed contracts, collect and sort the plastics, the possibilities of recycling are low if not someone demands exactly that precis material mixture. In most cases the plastic is sent for energy recovery.

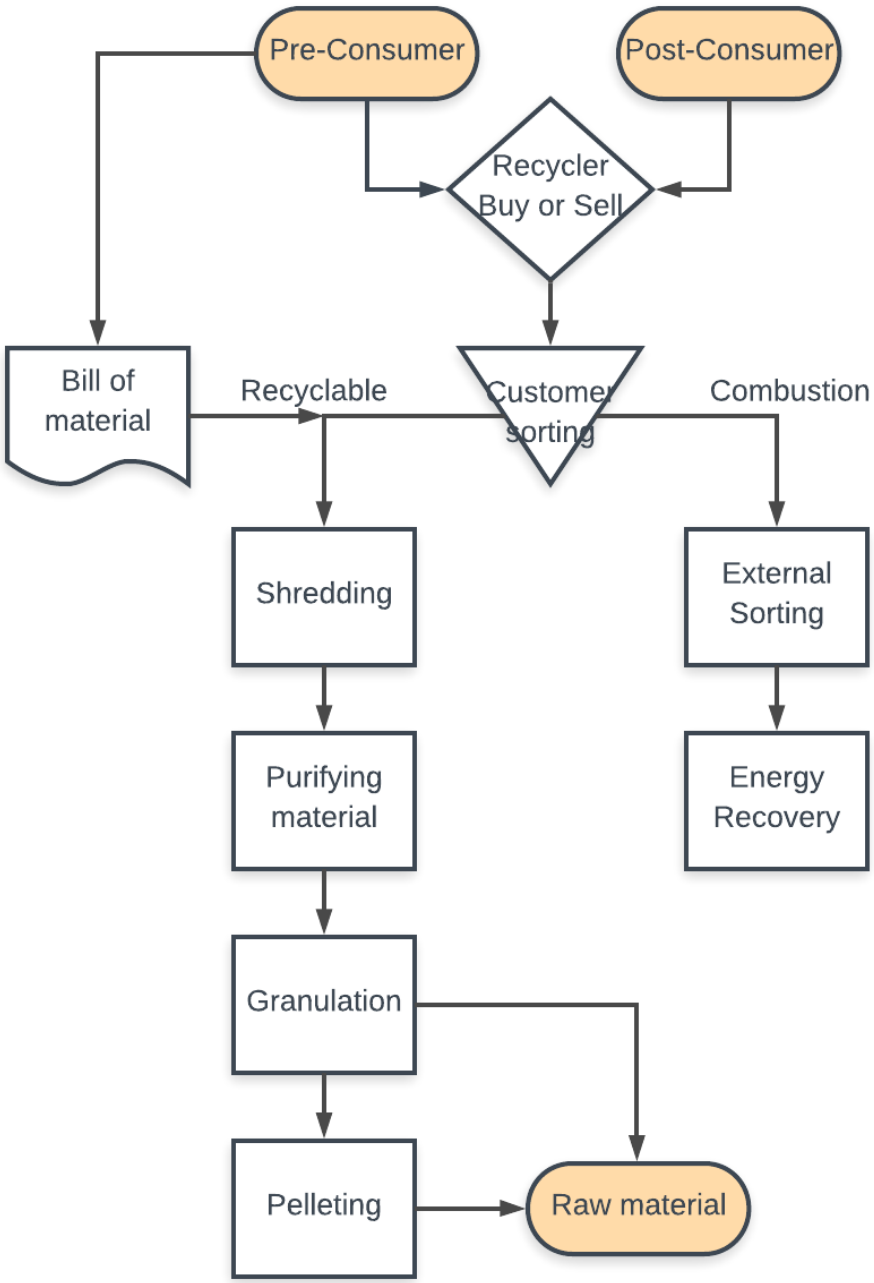

Figure 15: Supply Chain Flow - Recycler

5 Analysis and Results

The analysis and results will consolidate theoretical framework with empirical findings to analyse how each case company, Nolato and Essity, is currently working with CE and SCM in their SC´s. The analysis will follow the structure of the analysis model presented in chapter 2.5. Each chapter is divided by the SC activities, Procurement, Production and Distribution, where the business model and incentives for change are included in each chapter. Circular loops represent a subheading where the empirical findings are analysed to understand how circularity is currently performed and how it could be done. The possibilities of how circularity could be performed are based upon the theoretical framework and are further developed and analysed in last subheading, Barriers and Enablers. That section starts with the four questions of Why, How, What, Who from Dekker et al. (2003) to understand the possibilities of CE in each specific SC activity within the scope. Finally, a summary of all analysed CE enablers and barriers for each SC are presented in a table.

5.1 Circular Economy in Procurement

The following section includes an analysis of the empirical data of procurement presented in chapter 4.1, in combination with the theoretical framework to partly answer the RQ: What are the barriers and enablers of working towards a Circular Economy? with the result presented in chapter 5.1.2. Chapter 5.1.1 focuses on the economic advantages for Nolato of transitioning towards CE.

According to Miemczyk et al. (2012) procurement and supply management has a central role in a company's work with sustainability and a company is no more sustainable than its suppliers. This just emphasises how important it is to incorporate sustainability work upstream within a company to create a stepping stone for the sustainability work throughout the entire company. Since Nolato always recommend materials and suppliers that they currently work with to their customers, they get a narrower material dispersion compared to if the customer gets a free choice. This is shown by the fact that just four materials constitute 90 percent of the yearly purchase. By purchasing few materials Nolato create conditions for easier recycling. Since the use of few materials within the products decrease the need for separation and creates high quality plastic waste. Easy sorting in combination with full knowledge about the material content provide conditions for a closed-loop SC (Huysman et al., 2017). This would enable Nolato to use products with few material components in a closed loop where they put unusable products back into their own material system. Currently, Nolato purchase less than 5 percent of recycled plastic. However, by using a closed-loop SC they would have knowledge that the recycled material is of the high quality and the specific material that Nolato desire. Further, they would not have to pay for sending unusable products to combustion, but instead get paid by just separating product groups and they would also preserve some value of the products that cannot be sold. Since recycled material is cheaper than virgin, a closed-loop SC would also decrease the costs for material purchase.

In a wider perspective, if Nolato would transition towards a CE this would be in line with the upcoming legislation from EU and they would improve their CSR. An objective with the upcoming legislation is to both reduce CO_2-emissions and decrease the dependency of fossil fuels. By transitioning to a CE Nolato would decrease CO_2-emissions in two main ways. Circulating unusable products would eliminate the emissions created from combusting these products. Further, by purchasing recycled plastic Nolato would also contribute to eliminate the emissions that comes from the production of the same amount of virgin plastic. As described by Koch et al. (2017) a CE also decrease the dependency of fossil fuels, since virgin material only needs to be put into the material system when material leaves the system or when there is a need for increased capacity. Otherwise the comprehensive material system is self-sufficient as long as material is taken care of in the right way. Transitioning towards a CE would also increase Nolato's CSR and strengthen their sustainability profile. According to Uddin et al. (2008) choice of suppliers, materials, transportation and marketing are some SC activities that must be adapted for the environmental dimension of CSR. Purchasing recycled material shows both a good choice of material and suppliers. Further, Nolato would really make a statement in relation to the demand that their suppliers should take environmental responsibility.

In relation to the four risks presented by Chopra & Meindl (2016) Nolato could handle both *price of inputs* and *fractions purchased from a single source* by transitioning towards a CE in their procurement activity. By purchasing recycled material that is created from old plastic there is a previously set price, compared to the fluctuating price of oil and thereby the price becomes stabilized. This is further strengthened by Koch et al. (2017) who describe that a closed-loop system provides the market with a more stable price compared to the use of virgin materials. By stabilizing the price of plastic, it allows companies to focus on their core business to gain maximum profit. With a fluctuating price on raw material companies must hedge themselves with e.g. financial instruments, have fluctuating profits due to increasing or decreasing costs or change their sales price to keep a stable profit margin. However, since Nolato's business is to develop and sell plastic products and not speculate whether the oil price will increase or decrease it is positive to mitigate this risk as much as possible. To contribute to develop a functional circular system there is a need to both gather and recycle products as well as creating a demand by purchasing recycled materials (Koch et al., 2017). This statement emphasizes the importance of purchasing recycled plastic in order to develop the recycling industry. Thereby, expanding the recycling industry and allowing for more research to create better plastic as well as creating new sites to ease the logistics of scrapped products. Stahel (2013) further describe the smaller the loop (activity-wise and geographically) the more profitable and resource efficient it is and that the speed of circular flows is crucial. So, by purchasing more recycled plastic it is possible to increase the speed of circular flows and in the long run enable establishment of more sites to create smaller geographical loops. However, the current network of recyclers is limited and depending on the desired material and volume it could be difficult to acquire. Until the recycling network is developed, and CE is established throughout the plastic industry, recyclers should be used as suppliers to mitigate the risk of *fractions purchased from a single source*. By

purchasing a part of the material from a recycler the risk connected to incomplete delivery from the virgin plastic supplier is reduced. However, until the market for recycled plastic is fully developed Nolato should only use recyclers as additional suppliers since the supply is uncertain for large volumes.

5.1.1 Circular loops – The possibilities for circularity

By transitioning towards a CE, it is also possible to have financial benefits and not just environmental. With a cost of 5.1 SEK for each plenum in virgin material cost and a yearly production of 50,000 pieces, Nolato has a yearly virgin material cost of 255,000 SEK. By purchasing recycled material, it is possible to reduce these costs to 82,500 SEK (table 10).

$$\frac{1.1SEK}{kg} * 1.5kg * 50{,}000pcs = 82{,}500\ SEK$$

However, it is vital to secure the quality of the recycled material to not increase the number of products with quality issues. Therefore, it would be favourable with a closed-loop SC to have full control of the origin of the recycled material. Regarding the oil pipes Nolato produces 120,000 each year where each cost 0.625 SEK in just material. By changing the procurement strategy and purchase recycled material instead it is possible to reduce these costs to 24000 SEK (table 10).

$$\frac{1.6SEK}{kg} * \left(120{,}000pcs * 0.075kg + \frac{120{,}000pcs}{2} * 0.1kg\right) = 24{,}000\ SEK$$

The cappings have a complex material combination and there have not been any sales notations of this mixture for recycling purposes. The cappings consist of two components who each are a mixture of two unique materials. So, to circulate the material in cappings Nolato must firstly separate the two components. Thereafter, establish a closed-loop SC so Nolato can secure demand of these recycled mixtures and ensure the recycler that there is a customer willing to purchase this mixture.

Table 10: Potential cost reduction from purchasing recycled material to the three case products

Product	**Purchasing cost of virgin material (SEK)**	**Purchasing cost recycled material (SEK)**	**Cost reduction (SEK)**
Plenum	255,000	82,500	172,500
Oil pipes	75,000	24,000	51,000
Cappings	38,820	Unknown	

Further, procurement has an important role of coordinating and especially linking activities for a successful CE. For products to circulate, there must be an activity that either purchase the recycled material or take-back scrapped products into the company. Without incorporation of procurement in CE it is likely that supply of scrapped products

or recycled material will exceed demand to a level where the linear SC of make-take-dispose is the only solution and combustion is necessary to reduce waste. Witjes & Lozano (2016) describe it as procurement has the important role in CE of bridging consumption and products by transforming products that is considered as waste into resources.

5.1.2 Results

This section will present a partial result of the study by answering the parts of the research questions including procurement.

What is important when transitioning a SC towards CE regarding the case companies Nolato and Essity:

- **How can the transition be proceeded?**
- **Why is the transition towards CE important?**
- **Who will be involved in the transition?**
- **What products or materials should be included or prioritised in the transition?**

Why Nolato should incorporate CE in the procurement function have four main reasons. First, since a company is no more sustainable than its suppliers (Miemczyk et al., 2012) it is important to choose the right suppliers to truly incorporate the values of CE. Second, it would strengthen their sustainability profile and they would take a larger responsibility by both reduce CO_2-emission from combustion and reduce the dependency of fossil fuels by increasing the demand for recycled plastic. Third, incorporating CE would reduce risk by having multiple suppliers to source material from and since the price of recycled material is not dependent on the oil price. Fourth, there is a financial potential to exploit by transitioning towards CE.

How Nolato should incorporate values of CE in the procurement function is by purchasing recycled material to use in their production. Further, it is important that CE is reflected in the business model in not just in small parts of the company since that could lead to sub-optimizations.

What type of recycled material that should be purchased is highly dependent on the possible supply. Since the supply of recycled material can variate it should firstly be incorporated in the four high-runners the constitute 90 percent of the material purchased. Combining two suppliers of virgin and recycled material eliminates the dependency of supply of recycled material and allows for fluctuation which can be mitigated with virgin material.

Who that should be responsible for the actions taken should be a joint effort between the procurement function and the board of Nolato. Although the procurement function is responsible for the operational task of purchasing the material it is important that the board takes the tactical decision to purchase more recycled material.

What are the barriers and enablers for Circular Economy in Procurement, Production and Distribution?

Table 11: The enablers in procurement for Nolato to transitions towards CE

Enablers	**Motivation**
Savings	Due to the large volume of plastic that Nolato purchase it is possible to make substantial savings by purchasing recycled material, that is cheaper than virgin material.
Legislation	With the upcoming legislation from EU it is important to be prepared for the changes that will come.
Price fluctuations	Purchasing recycled material that comes from products with a previously set price makes price fluctuations smaller. Compared to the price of virgin plastic that is highly dependent on the oil price.
Large volumes	With the large volumes that Nolato combust there are great possibilities to establish a closed-loop supply chain with a recycler. Compared to small volumes where the recycler must create costly ad hoc solutions due to irregular deliveries.
CSR and Sustainability profile	Purchasing recycled material would increase the environmental responsibility from Nolato. Further, Nolato would really lead by example with the environmental demands they have on their suppliers.
Future uncertainties of oil	Since almost every product from Nolato is plastic and thereby dependent on oil it would be preferable to decrease this dependency due to future uncertainties of the oil price.

Table 12: The barriers in procurement for Nolato to transitions towards CE

Barriers	**Motivation**
Quality	Since Nolato's products have high quality demands it is vital to ensure the quality of the recycled material to avoid additional unusable products.
Supply	The current market of recycled plastic is not at a level where every company can purchase material at any desired volume. The volumes available is uncertain and needs to be backed-up with virgin material to secure the material supply.
Business model	Since CE is not included in Nolato's current business model it is possible that it could take a long time before the philosophy is fully incorporated.
RL coordination	In the event of establishing a closed-loop SC there will be additional actors to Nolato's SC. For an effective return flow of recycled material there is a need to coordinate all these actors which could be both costly and time consuming.

5.2 Circular Economy in Production

The following section will firstly present an analysis of the empirical data of production presented in chapter 4.1, in combination with the theoretical framework to partly answer the RQ: What are the barriers and enablers of working towards a Circular Economy? with the result presented in chapter 5.2.2. Chapter 5.2.1 is an analysis of the economic advantages of transitioning towards CE.

From the three chosen case products combined Nolato loses around 871,000 SEK every year because of products that do not meet the quality requirement and therefore cannot be sold. However, without improving any production process, it is possible for them to decrease these value losses by transitioning towards a CE. According to Sundhall (2018) complex material mixtures without traceability is often unfeasible to recycle and a bill of material is important to provide customers of the recycled material insurance of the material specifications. Both these criteria are fulfilled for two of three case products, since Nolato have complete knowledge about the material content and the plenum and oil pipes consist of a single material. Using the same material throughout a product is a key concept that has been proven in reality by Axjo that eases recycling by eliminating activities like dismantling and sorting (Gaardsdal, 2018). By using the same material, it is possible to recycle a product in one piece and thereby saving time, resources and money. The only activity that needs to be done is to remove all metal from the plenum and the oil pipes. Since plastic has low density it would also be preferred to size-reduce the products to increase the truck-load, but it is not required. The cappings on the other hand have a complex bill of material for recycling purposes, consisting of two components, each including two unique materials. Sundhall (2018) describes that recyclers decide if a product will be profitable for recycling and what the customer must pay or be paid for a well-balance business, where the highest paid material is when the customer handles all activities in the SC. This means that Nolato needs to separate the two components to get paid as much as possible. However, since there have not been any transactions for the specific material mixture (Sundhall, 2018) the recycler must assure that the recycled material can be sold for a well-balanced business. So, the probably only solution to avoid combustion is to establish a closed-loop SC where Nolato buy back their own material mixture. However, if this is an economically sustainable solution would require further investigation outside this study.

Jonsson & Mattsson (2009) describe that production operations include activities like enabling possibilities for set strategic company goals, demand efficiency and most important, co-ordination between all activities. These strategic company goals come from the business model according to Zott et al. (2011). Therefore, it is important to have a close connection between production operations and the business model. So, if Nolato wants to transition towards a CE it is important that this is displayed in the business model to avoid sub-optimisations within the company. Since the product is the core of Nolato, i.e. how they make money, it is also important that the production and product design is designed for a CE (Webster, 2017). For Nolato, this means designing products with as few materials as possible and make separation of components an easy task. Even though

a product maybe cannot be recycled and re-enter the own production the material could be sold to recyclers for future use in products with lower quality demands. Sundhall (2018) describe that customers that handles all activities in the SC get highest reimbursement.

5.2.1 Circular loops - The possibilities for circularity

By transitioning towards a CE, it is possible for Nolato to save around 22,000 SEK every year on two (plenum and oil pipes) of the three case products with relatively easy measures. From the categorization in figure 16 made by Huysman et al. (2017) both plenum and oil pipes should be considered as high or medium quality plastic waste. Since the waste comes directly from production it is clean and has not been exposed to other materials or fluids. With easy solutions of sorting Nolato has complete knowledge of the material content in each container with production waste. Further, the plenum and oil pipes both consist a single material throughout the product. Clean material, complete knowledge and single material combined should be enough for a quality of recycled material to go back to the own production or at least be used in other products. The figures in this chapter is independent if the material returns to the own products or not but based on just that the material is recycled.

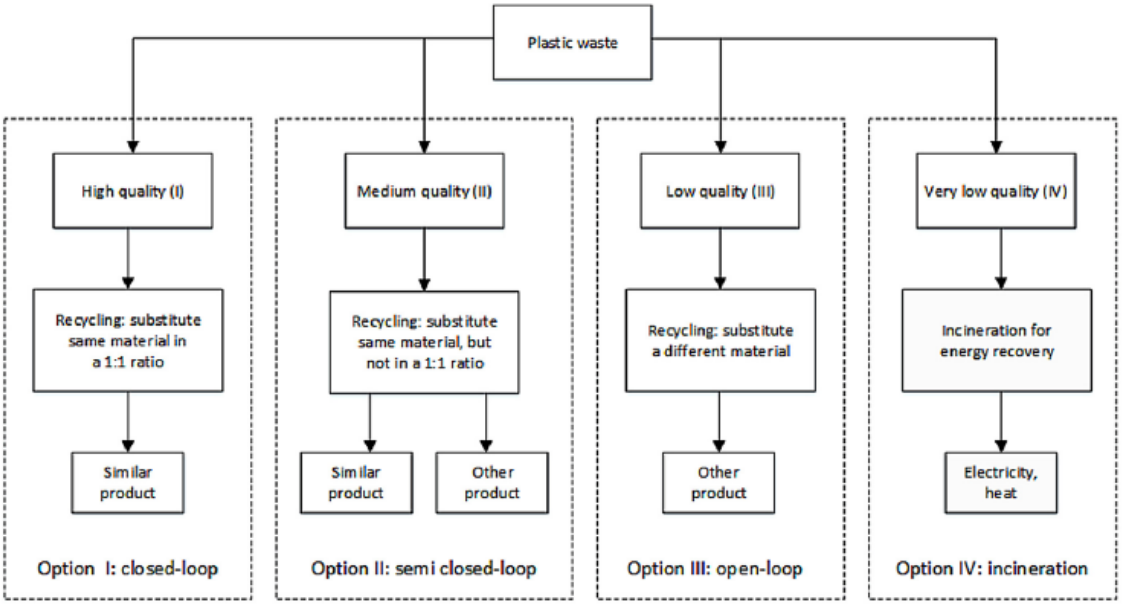

Figure 16: Different waste treatment options. Huysman et al. (2017)

Since there is no demand from external parties for the material combination in the cappings, it is not certain that it would be profitable to establish a circular solution. So, as reasoned in chapter 5.2 it would require further investigation to conclude what is feasible. The savings constitute of both that Nolato does not have to pay for material disposal and the earnings from selling the material to recyclers. The cost of material disposal is a known factor presented in chapter 4.1.2.2 and presented in table 14 and by sending the material to recycle this cost is eliminated. According to Sundhall (2018) the price for

production waste that recyclers offers for PP and PA6 is 0.5 SEK/kg and 0.8 SEK/kg respectively. Currently Nolato sends around 9,750kg of plenum and 7,170kg of oil pipes to combustion each year. By selling this production waste they would earn 4,875 SEK and 5,736 SEK of plenum and oil pipes respectively. In combination, the eliminated costs and earnings from recyclers would reach a total of around 22,000 SEK each year for just plenum and oil pipes. This highlights that there are possible financial benefits with CE in addition to societal and environmental benefits.

Table 13: Total gains from recycling instead of combustion.

Product	**Removed material disposal cost (SEK)**	**Earnings (SEK)**	**Total gains (SEK)**
Plenum	6,680	4,875	11,555
Oil pipes	4,911	5,736	10,647
Cappings	No demand	No demand	

5.2.2 Results

This section will present a partial result of the study by answering the parts of the research questions including production.

What is important when transitioning a SC towards CE regarding the case companies Nolato and Essity:

- **How can the transition be proceeded?**
- **Why is the transition towards CE important?**
- **Who will be involved in the transition?**
- **What products or materials should be included or prioritised in the transition?**

Why Nolato should return unusable products in the flow is because of two main reason. Firstly, it provides them with economic benefits of both avoiding the material disposal cost and getting paid from recyclers. Secondly, it should be done for environmental reasons, both to reduce CO_2-emissions and to their environmental profile.

How Nolato should incorporate CE into their production and products are by incorporating CE in the business model since that is coordinating the entire company. Further, they should aim at finding a recycler that hopefully can handle all their material, but otherwise act as a middleman distributing the material they cannot handle onwards to other actors. By contracting one recycler Nolato lower their transaction cost and since recycling is not Nolato's core competence it should be as easy as possible.

What type of products that should be involved in the return flow is first and foremost the ones the consist of a single material, since these are easiest to handle at an early stage of the transition. For future development, nearly all products could be involved in a closed-

loop SC provided that product design allows for easy separation of components with different materials.

Who that should be responsible for the actions taken should be a joint responsibility between Nolato and a recycler. Sundhall (2018) describe that customers that handles all activities in the SC get highest reimbursement. So, the economical dispersion between the actors depend on the effort Nolato wants to make with removing metal, separating components etcetera.

What are the barriers and enablers for Circular Economy in Procurement, Production and Distribution?

Table 14: The enablers in production for Nolato to transitions towards CE

Enablers	**Motivation**
Volume	With the high volumes that Nolato sends to combustion it is possible to establish a partnership with frequent deliveries according to schedule. Compared to low volumes which are sent randomly, whenever a container gets full. Further, it is possible to establish a flow where, provided the material has demand, Nolato's production waste could boost the business of the recycler.
Few materials	Many of Nolato's products consist of few materials which ease recycling since it removes the activity of dismantling. This creates possibilities where many unusable products just have to be placed in a separate container before transportation to a recycler.
Savings	As reasoned in chapter 5.2.1 there are possibilities of saving money by sending unusable products to recyclers instead of combustion.
Value recovery	With the savings mentioned above it is possible to recover some of the value that is lost since the products cannot be sold.
Traceability and material knowledge	Nolato has knowledge about the material content, it has not been exposed to other materials or fluids and can with easy measures be separated into different containers. These are all factors that makes recycling easier and increase the value of the material that will be recycled.

Table 15: The barriers in production for Nolato to transitions towards CE

Barriers	Motivation
Core competence and business model	Since Nolato's core competence is to design and produce the products they want simple and effective ways to get rid of the material. Further, it is not included in their current business model to handle to production waste, which could take time to change.
High customer focus	Even though Nolato suggests materials that they currently use to their customers they still have a high customer focus. This could be a barrier since the customer can choose material mixtures that is not suitable for recycling.

5.3 Circular Economy in Distribution

The following section includes an analysis of the empirical data of distribution presented in chapter 4.2, in combination with the theoretical framework to partly answer the RQ: What are the barriers and enablers of working towards a Circular Economy? with the result presented in chapter 5.3.2. Chapter 5.3.1 focuses on the economic and value preservation advantages for Essity in transition towards CE.

Regarding CE in distribution the SC surplus is highly related, the choice of SC maximizes the total value for customers and SC actors. There is nothing which hinders companies to only chose one SC design, Essity utilizes the benefits of poly dynamic SCM and has created two SC´s for the same product. SC surplus must therefore be calculated for each SC and will not give and objective result if consolidated as one SC Chopra & Meindl (2016). Essity chooses to give away dispensers when a customer agrees on a contract and the manufacturing costs for dispensers are covered by higher prices on supply like paper and soap during the contracted periods. If the SC surplus is calculated on dispensers it will result into a "customer value" equal to 0 and therefore the SC surplus will be negative for dispensers, if not the "SC Costs" are equal to 0, which is not the case. The choice of SC does not affect the surplus in any way since it does not matter which distribution channel each dispenser sells within. The contract deal including free dispensers can occur in both channels however is mostly common in the "Essity Distribution channel". The other distribution through distributors is more flexible and the contract is highly depending on who the customer is and the purchased quantity. SC Costs differs in the two distribution channels, more actors are included in the "Distributor" channel and therefore must have higher costs regarding transportation and warehousing. The higher costs must be covered and if the Customer Value equals 0 the overall SC surplus will be lower. This basic analysis of dispensers SC surplus shows that if the "Customer value" equals to 0, the Distributor distribution channel will have the lowest SC surplus compared to direct Essity Distribution. The report has not included any sale numbers within each distribution channel regarding the contract types if dispensers are sold or given for free. Thus, no further analysis of the SC surplus is addressed for each type of sales method. The essential and crucial information regards the distribution split, 50 percent of all sales goes through and is divided between each channel. The exact numbers of actors, which Chopra &

Meindl (2016) finds crucial to be aware of to maximize the value share, is well known for the Essity Distribution and less clear within the Distributor distribution channel. Hence, lost ownership and tracking of dispensers in the Distributor Distribution channel minimizes the awareness of included actors in the SC.

The overall infrastructure is described as an important factor for business relationships and business strategy (Ford et al., 2003). Distribution is a key driver of a SC´s profitability and requires a reliable infrastructure, Essity has a vague infrastructure in terms of traceability and awareness of actors and customers in the SC. CE is not introduced in any SC and the possibilities are not developed nor investigated. The infrastructure is also highly connected to strategic decisions and overall structure of company visions, Zott et al. (2011) define these as a Business Model. Essity has a business strategy which does not correspond with CE regarding distribution.

Distributor Distribution is least circular of the two channels, the ownership of dispensers is lost in an early stage and the traceability is low, possible, but no incentives which embraces the need for it. Essity Distribution enables traceability and ownership until the first user, however the current business model considers and is trigged by marketing benefits over CE. Incentives for current business model cannot be analysed, empirical data does not cover this area for any clear indications. However, after dispenser usage, customers keep them, and they are still up for marketing purposes which indicates less concern about CE.

Essity Distribution has higher possibilities of CE due to the ownership of products, if Essity wants, the dispensers can be drawn back into circular loops. Comparing Essity and the case companies from chapter 2.3, a clear view regarding business model is presented. All companies work highly with a strategy and vision which motivates CE. The cases are of various sizes and the Renault Short-loop case demolishes the hypothesis of; smaller companies can easier adapt an CE business model.

One trend of CE is the “Solutions will overtake Products” and PSS is an essential tool for this transition (Neely, 2014). PSS is referred to a future business model for a sustainable CE, Mont, (2002), Manzini & Vezzoli, (2003) and Tukker & Tischner, (2006) characterizes PSS as an enabler of allowance for ownership retrieval. PSS has the potential to extend Essity´s ownership of dispensers which will improve the resource efficiency and traceability. Mont (2002) addressed numerous benefits of PSS, those which fits best with Essity and their circumstances regarding value losses would be the organizational benefits of; reclaiming more product value, maintaining a high market share hence the difficulty of coping a service, one becomes supportive of circular consumer behaviours. Mont´s (2002) customer benefits are equally important, however, the customer perspective is not cover in the scope of this report.

Incentives for changing to a CE business model requires strategic visions which corresponds to sustainability and with circular aspects (Ford et al., 2003). Hence, the

economical and sustainability incentives are what drives for transition, if not legislative regulations overpower strategic decisions. Economic benefits for Essity is of course the retrieved value of plastic material, and the possibility to disrupt a new market, or with other words, Essity´s current market which is left behind. The market does not currently have competitors which strengthens benefits for Essity´s economical possibilities (Investopedia, 2018). Economic benefits seem to be the biggest incentive, however Li et al. (2017) reminds of the consequences for focusing mainly on economic benefits and one should also pay attention to the environmental benefits of CE.

5.3.1 Circular loops - The possibilities for circularity

After the first user regarding dispenser, the product is either still up for marketing purposes and used with competitors' supply or handled by a firm for renovation. Since plastic products requires a bill of material and cannot be mixed for best recycling (Nationalencyklopedin, 2018), the dispensers are assumedly sent for energy recovery if handled by someone external. Energy recovery is not necessarily bad, but value is lost in terms of material- and cash value. One Essity distribution contract is for 3 years and the lifetime of each dispenser is set for display and design purposes to 8 – 10 years. 70 percent of Essity customers renew their contract, a contract renewal will retain same or with minor changes.

Each year product H1, S1 and S4 represents a total of 1,278,130 kg sold mass, since the products were built on average of 80 percent ABS plastic the representative mass will instead be 1,022,504 kg ABS plastic each year. The value is not retrieved by Essity since recollection is not performed it, the value is estimated with recycling current prices (Sundhall, 2018) to 6.6 M SEK / Year. ABS is a highly demanded plastic which could enable an incentive for recollection, either as RL in a closed-loop or for external recycling. The material value is higher since it is produced with virgin raw material which is more expensive than the price for recycled materials. Retrieving value is not only about recycling, "The Circular Economy" loops shown in Figure 1 includes motivations for circularity after the first user as Reuse and Remanufacturing before recycling is considered. Stahel´s (2013) five principals of what circularity is reminds us that in Essity´s situation, reuse would be the most profitable and resource efficient when it comes to circularity.

Essity´s dispensers are located in various environments and public areas strain the durability, still the life-time is often more than 8 years. After the first user, even if or if not, the customer extends the contract deal, reuse is often a case due to the durability and high quality of dispenser. Essity advocates reuse of dispensers to some extent, the reuse with competitors' supply is okay as long the dispenser is shown publicly and marketizes the Essity brand. If a customer renews a contract reuse is not motivated by Essity, customers have the possibility to renew their dispensers for the same cost, this means if a customer chose to have the same dispensers, the deal would be the same as if the customer took new dispensers and kept the old one´s for whatever reason. Remanufacturing is one loop which neither is considered, remanufacturing requires work that seems too much for

the effort and result. The dispensers are already robust and has high quality, therefore the argument from Lee et al. (2007) of life-time improvement seems vague in this case.

Design coordination with strategic control and directives is one important factor of CE, Webster (2017) addressed the principals of circularity regarding product design. Essity has dispenser which characterizes and reflects the concept of "Design for life" hence no clear indications of the purpose relating CE. The concept of design for life is to eliminate a behaviour of the make take dispose system. Essity provides dispensers which follows a clear design for life concept but lacks within the ability of eliminating the disposal system and designing for remanufacturing. Design for recycle within the concept could also be an issue but the specific dispenser design is not researched for further analysis. EU will take actions to improve product design for plastic recycling (European Commission, 2018), and the design for life concept would be suited for this preparation of transition.

5.3.2 Results

This section will present a partial result of the study by answering the parts of the research questions including distribution.

What is important when transitioning a SC towards CE regarding the case companies Nolato and Essity:

- **How can the transition be proceeded?**
- **Why is the transition towards CE important?**
- **Who will be involved in the transition?**
- **What products or materials should be included or prioritised in the transition?**

Why should dispensers be returned in the flow based upon the scope and background, relies on the corporate social- and environmental responsibility. And of course, for the economic benefits that CE generates. The main reason of why dispensers should be returned is for value retrievable- and environmental benefits. If dispensers are returned in the flow after distribution, value will be saved and retrieved which else would be lost.

How value is preserved depends on which circular loop is motivated, most value is retrieved from the closes loop, which would correspond into a reuse loop. Least value would be retrieved from recycling however since remanufacturing is strictly against current business model, the required investments for remanufacturing would overtake the benefits, therefore, recycling would be next loop to preserve some value from dispensers.

What products which should be considered in a RL are within the scope and cases plastic materials, the report background motivates why specifically plastic materials are researched and therefore all Essity plastic products are included and represented by the dispensers. The motivation for RL regarding dispensers is the high lost value and high

usage of ABS plastics, which is a high price plastic. The current non-functional value preservation of these dispensers motivates these specific products as well.

Who will take the responsibility of RL activities relies on SCM and all actors within a SC. Essity has two main SC´s for distribution, and for a well-functioning CE distribution all actors must be involved. In the "Distributor distribution channel" more actors are included which will complexify the responsibility tasks. A SCM coordination is crucial and must be functional for a successful CE.

What are the barriers and enablers for Circular Economy in Procurement, Production and Distribution?

Table 16: The enablers in distribution for Essity to transitions towards CE

Enablers	**Motivation**
Ownership	Essity distribution allows Essity to possess ownership enables and enhance ownership for Essity, however the ownership is given away and not taken advantage of in any way. Ownership enables for recollection and the right to obtain benefits for collected value Mont (2002).
PSS - "Solutions will overtake Products"	One of the trends with CE is that solutions will overtake products, Essity does offer solutions with contracts and continuous supply refill of paper and soap. However, the concept of PSS is more than just offer solutions (Neely 2014). PSS has the potential to improve traceability and ownership while reclaiming more value of the dispensers. Solutions and services are much harder to copy, therefore PSS can offer economic benefits Mont (2002).
Market possibilities	Investopedia (2018) addresses the benefits the new market CE can offer, if Essity recollected all dispenser, even those outside of this report´s scope, a new market would be disrupted. The enabler within this case is that the market is un discovered and has no competitors.
Product design	Essity has proven their products to last and be durable, 8 to 10 years of a plastic product to last physically and ecstatically indicates a well thought design. Design for life principals are applied for the dispensers when it comes to reuse aspects of durability, quality, design and upgradable Stahel (2012). However, design for remanufacturing and recycling is less considered for a CE within Essity.
ABS plastic	The dispensers consist of 80 percent ABS plastics, ABS is a highly demanded and "exclusive" plastic (Sundhall, 2018). The

	exclusivity of chosen material enables and should motivate Essity to recollect and take advantage of this material to its fully potential and value.
Legislation	EU will take actions for plastic circularity (European Commission, 2018), the action of product design improvement for plastic recycling could motivate Essity to become more sustainable when it comes to product design for CE.

Table 17:The barriers in distribution for Essity to transitions towards CE

Barriers	**Motivation**
SC Actors	If a SC has more stakeholders the SC surplus must be divided with all, a smaller share will be given to everyone Chopra & Meindl (2016). Actors within a SC which not are identified, will act as a barrier for CE since coordination with all actors is a crucial CE success factor (Zott et al., 2011) & (Ford et al., 2003)
SC Infrastructure and Business Model	Distribution is a key driver for CE, Essity´s strategic infrastructure does not correspond with circularity and CE (Ford et al., 2003). Essity´s infrastructure does not support traceability of dispensers nor traceability of SC actors and customers. The strategic idea of marketing purposes relies on strategic directions, which are related to the business model. This model diminishes the idea for circularity.
Ownership	The ownership of dispensers is given away to customers and not preserved for value retrieval. The loss of ownership is a clear CE barrier and does not enhance circularity in any way.
Economic Incentives	Li et al. (2017) states that if only economic benefits are the key driver for a CE transition, one will face consequences. Essity has a focus on only economic circular incentives, e.g. the circular loop of reuse is purposed for marketing benefits and not environmental aspects.
External Recycling	For the average consumer, recycling could be difficult. The dispensers are relatively modular however recycling of plastics require a sorting for each plastic (Nationalencyklopedin, 2018). Which is assumable impossible for the average consumer without a bill of material or the possibilities to sort out each plastic by itself.
Product life time	The product life time does not correspond with contract duration. Especially if circular loops are not a consideration. Example, if 70 percent of 100 customers renew their contract, that will result in only 24 customers left after the estimates 10 years of durability and design lasting. (One contract is 2-3

	years. A product should accordingly last 10 years which equals 4 contract renewals => (100*0.7^4 = 24)).
Recollection	Actions within SCM correlates to strategic directions, the business model of Essity prioritises marketing before circularity. Contract renewals includes the opportune to update dispensers for no extra costs, the price is the same for contract renewal with new dispensers or if the customer choses to keep the "old" ones. A customer could potentially end up with a double set of dispensers, or just renew for ecstatically purposes and the old dispensers will be left behind in the customers responsibility.

6 Discussion

In this chapter, the results from the two cases is discussed and how these results can be applied to any SC working towards a CE. In each section, discussions will be presented of how the results contribute to the study´s purpose followed with limitations of the study´s structure.

6.1 Case A – Pre-Consumer Circular Economy

The case of Nolato shows that there are both economic and environmental benefits with the introduction of CE and that companies can contribute with relatively easy measures. Further, it highlights the possibilities of circulating products that have not reached the consumer, due to the traceability, cleanness and material knowledge. Since Nolato is far from a fully developed CE there has been little to no focus on reuse and remanufacturing, but instead mainly focus on moving away from combustion. The focus on recycling is also due to the characteristics of their products that consist of few components that cannot be change or repaired. That means that if some part of the product has errors, the entire product is unusable. That is probably a common factor for production waste, that recycling is the most preferable solution for a CE. Reuse and remanufacturing are more suitable for an entire product, which can be repaired or still has its functionality even though one user does not want it anymore. With the knowledge of material content, recycling becomes much easier which also highlights that recycling is probably the most suitable solution for production waste. In comparison to products that have been sold and left the producer, where it can be difficult to identify the material content without proper marking, which aggravates recycling.

If large companies like Nolato would both enter material into the recycling market and withdraw material by procurement, it would probably boost the entire recycling industry for plastics. With barriers like quality issues and uncertain supply for purchasing recycled plastic, there is a need to expand the market for plastic recycling. Expanding the market makes it is more attractive for investments to improve the quality of recycled plastic. However, for the market to expand, companies must initiate the expansion by supplying material and especially purchasing the recycled material to increase the circulation of plastic. Expanding the market would also allow for establishment of more recycling sites and thereby ease logistic issues due to decreased distances. Since logistic costs is high relative to the material value it is important to expand the network to decrease these costs. Even if companies like Nolato, with high quality demands on their product have difficulties using the recycled plastic it is still positive if they supply the market. Since there are plastic products with lower quality demands where the recycled plastic can be used and instead, products with high quality demands can use as much high-quality recycled plastic as possible, combined with virgin plastic.

The coordination between actors on different levels need to be more inline and is a major barrier for enabling CE for plastic in a wide perspective. The different levels of actors include different departments within a company, other actors such as logistic companies and recyclers, and governing entities such as the European Union. The upcoming

legislation from the European Union about plastic in a CE is a step forward since it aligns the actors working with plastic. With common rules to follow it is easier to establish a network to create synergies and gain as much value as possible. To pursue CE, it is necessary to involve external actors that have other expert areas than the focal company. Reusing requires measures to transfer the product between users, remanufacturing requires specialized companies and products that are possible to remanufacture, and recycling require recyclers and logistic companies. To circulate products with maximal financial gain it is necessary to coordinate with the actors needed for a specific flow. Within each producing company it is important to align the business model with CE to both coordinate all departments and design a product that eases CE.

6.1.1 Recommendations for Case A

This section presents short and concise recommendations to Nolato based on the previous analysis.

Closed-loop supply chain

Since quality of the raw material is a major concern for Nolato, they should aim at establishing a closed-loop SC, for plenum and oil pipes, with a recycler. Although it means that they cannot purchase more recycled material than the weight they provide the recycler with, it is a step in the right direction. With a closed-loop SC Nolato will have complete knowledge of how the material is handled until the recycler, thereby ensuring the material quality and material content. Further, it will provide some value recovery for the unusable products with eliminated cost of material disposal, earnings for selling the material and savings when purchasing the recycled material.

Investigate other products

Throughout this study there has mainly been focus on three case products. Due to the savings possible from two of these it is recommended that Nolato investigate if there are other products suitable for recycling. Meaning products that consist of one or two materials, have a high value and where a large portion are currently sent to combustion. However, it is important to compare the values gained to the cost of logistics for an economical sustainable business.

Contract with recycler

Since transportation planning and recycling preparation are not Nolato's core business, it should be as easy as possible to recycle their unusable products. Therefore, it is recommended to establish a contract with a recycler that can handles all, or a large portion of the material. This is to reduce the transaction costs and to avoid planning transports to different sites with different actors.

Circular economy in the business model

To get all departments to work with CE and ease recycling as much as possible it is recommended to include ways of working with CE in the business model. This is to have common guidelines within the company and avoid sub-optimizations. However, the main

focus should be on product design to make recycling of unusable products as easy as possible.

6.2 Case B – Post-Consumer Circular Economy

SCM is in broad terms about to enable and provide efficient flows within a SC, efficiency corresponds to costs, lead times, relationship management etc. During analysis, costs has been presented and analysed as SC surplus and value in various types. SC surplus might feel off-topic when discussing CE, however the core of SCM is highly related with value generation within a SC, therefore, the importance of SC surplus in a CE. Essity loses unidentified value each year and the distribution differ from customer to customer and from distributor to distributor. Even within one distribution channel for the dispensers, the SC surplus vary and is depending if a customer wants a complete solution with supply or just a dispenser. There is no data on the amount of sold dispensers and dispensers that are given away. The reason for giving away dispensers is to make contract deals more desirable and attractive for customers. However, accordingly during the contracted period of 2 or 3 years, the dispensers are owned by Essity or the distributor, depending on which distribution channel is providing that specific customer. After each contract the dispenser should be returned to its owner, and this is not the case due to a lack of recollection system.

The distribution system which enables highest SC surplus is not necessarily the best one. If only SC surplus was a crucial factor for success, then it would become obvious that Essity distribution would be the best solution due to less actors within the SC. The Essity distribution also allows higher traceability of dispensers. Tracking dispensers through distributors is assumedly hard and time consuming. Essity does not share any mutual data or software with their distributors. Tracking dispensers is a SCM action which is of high importance for a successful plastic loop circularity. The distribution is divided into 50 / 50 and the Distributor distribution of dispensers is further from circularity factors that Essity Distribution. For example, Essity distribution has the advantage of easier tracking and following up customers, planning of recollection, planning for future upgrades etc. and most important, the ownership of dispenser. Essity theoretically owns all dispensers during contract and after even if or if not, a customer extends the deal. The findings of Essity´s distribution methods and ownership of dispensers operate towards a brief understanding of what the issue is for being circular an achieving a CE. SCM provides three stages of activities and all are equally important, strategic, tactical, and operational. The strategic directions and business model affect the distribution and how the tactical and operational tasks are performed. If Essity had strategic directions towards a CE, all tactical and operational SCM activities would become natural tasks. Tracking dispensers, a tactical SCM operation would enable many more CE benefits and enable expansion within the area.

The overall infrastructure is what enables tactical and operational tasks, Essity´s infrastructure is not analysed in deeper terms; however, it is clear that the infrastructure does not support a RL. A non-supportive RL infrastructure mitigates the CE possibilities

for Essity. To enable a RL infrastructure Essity should focus on a suited business model which enables the transitions towards a CE. The limitations of infrastructure give clear indications of what is needed for CE development. Strategic directions must be clear and allow SCM activities to develop a circular friendly platform. The analysis provided an important SCM factor which is one of the most important factor for CE allowance, which is the strategic directions infrastructure enablers for circularity.

The analysis of current business model is only brief, still indications from quotes and actions, Essity has created a reality where marketing and economic benefits are more important than sustainability and environmental aspects of plastics and their dispensers. Keeping products in the market for marketing purposes is good but will only be beneficial if potential customers sees this marketing and that it promotes sales. Understanding exactly what SCM tasks for a CE business model require needs deeper research about specifically business models. The scope and analysis of this report provides enough information and notion for Essity to understand that their business model is not directed towards CE.

Solutions will overtake products, and Essity has potential to improve and fulfil their PSS to reach its fully benefits. It is not only about providing solutions if not the philosophy is on point. PSS includes more than just renting and creating solutions for customers. Ownership and responsibility should be on Essity still after post consumption for a successful PSS. PSS changes the business model and requires an SCM infrastructure that enables tactical and operational activities towards a CE. The benefits of PSS go well in line with circularity and SCM, Essity could retrieve more value from their dispensers, and retrieving something is more than nothing. PSS is a possible SCM tool for maintaining ownership and preserve value from dispensers, especially when dispensers are made from 80 percent expensive high-quality ABS plastic. The importance of environmental benefits corresponds well with economic benefits when preserving the value of dispensers due to their durable quality, high material value, modularity, and ideal characteristics for the circular loops.

Essity does not circulate dispensers and prefer not to, the incentives can be discussed and motivated differently. From a CE perspective, Essity´s business model which focuses more on marketing benefits than circularity possibilities eliminate important enablers for CE. The SCM forces between marketing and circularity are too high for success within the area of CE. The economic benefits which are gained from marketing are not calculated nor analysed but for a CE these will be ignored and not seen as a loss. The preserved value and sustainable advantage would clearly overrule marketing benefits and no proof that economic benefits would be higher within a CE are analysed, however, benefits of CE are clear as well.

Annually, Essity sells H1, S1 and S4 products including 1,022,504 kg of ABS plastic and that material value is not preserved. Benefits of circularity are the fact that smaller loops of reuse, remanufacturing and recycling can still end up providing users and combustion

facilities the exact same value. Circular loops use current value in a more efficient way, it does not create new value for the material. The actual material value will always be the same. Comparing with a product value, then value can be added through design and functionality, however the material value will always be the same, if not the actual material prices fluctuate.

6.2.1 Recommendations for Case B

This section presents short and concise recommendations to Essity based on the previous analysis.

Business Model

Enhance strategic goals and visions that motivates operational and tactical activities for a CE. The referred activities are related to every recommendation bellow which enables CE in SCM.

Circular Loop

Consider the circular loops of Reuse – Remanufacturing – Recycling in this specific order. Most value from the dispensers are preserved in this order according to literature. The remanufacturing loop is the one which is least analysed, therefore, our recommendation would be to start with considering reuse and recycling of dispensers in the first stage.

Product Service System

Essity distribution is currently proving service solutions for its customers, our recommendation relies mainly on the distributor distribution system but also Essity distribution. Essity should advance current PSS and track dispensers while keeping the ownership of dispenser.

Recollection

As seen from the successful CE cases, every case has a recollection system which enables all three loops of reuse, remanufacture, and recycle. The same system works for all three purposes and the recommendation to Essity would be to invest into one recollection system which can enhance all three circular loops.

Sustainable Incentives

Sustainable incentives of adapting CE instead of economic befits as an incentive for the transition. Sustainable incentives will accordingly to the analysis offer economic benefits among environmental and sustainable SCM benefits.

7 Conclusion

Combining pre- and post-consumer SC activities into one SC with common SCM factors, generalizes and creates a wider perspective of CE in SCM. Every SC differs and includes various SCM factors, however, even though the differences of SC design, activities, actors etc. the importance of a Business model and Incentives for CE are the foundation for SCM when working towards a CE. Adapting SCM factors on a tactical and operational level are required, these factors are the enablers and barriers for circularity and the circular loops.

Every SC will face different barriers and enablers due to different markets and circumstances, the objective is to identify what one´s specific SC characterizes for and what the specific solution could be for circularity and what the barriers and enablers are. The analysis model can be generalized and suited for many SC´s, the concept relies on the SC activities, e.g. Procurement, Production and Distribution which were chosen for the scope of this paper. We have chosen to name the model; "The Circular Supply Chain" and its purpose is for one to understand the importance of SCM and the relationship between a SC and important factors when working towards a CE. The model can be seen in figure 17.

RQ1: What are the barriers and enablers for Circular Economy in Procurement, Production and Distribution?

Barriers and enablers are unique for each situation, for specific case barriers and enablers look in chapter; 5.1.2, 5.2.2 and 5.3.2. Barriers and enablers of working towards a CE must be identified for each case and SC. Circular loops are what enables or hinders circularity and is therefore important.

RQ2: What is important when transitioning a SC towards CE regarding the case companies Nolato and Essity:

- **How can the transition be proceeded?**
- **Why is the transition towards CE important?**
- **Who will be involved in the transition?**
- **What products or materials should be included or prioritised in the transition?**

According to the developed model, "The Circular Supply Chain", important factors are Business model for CE and Incentives for CE. The importance of these are equally divided in all SC activities.

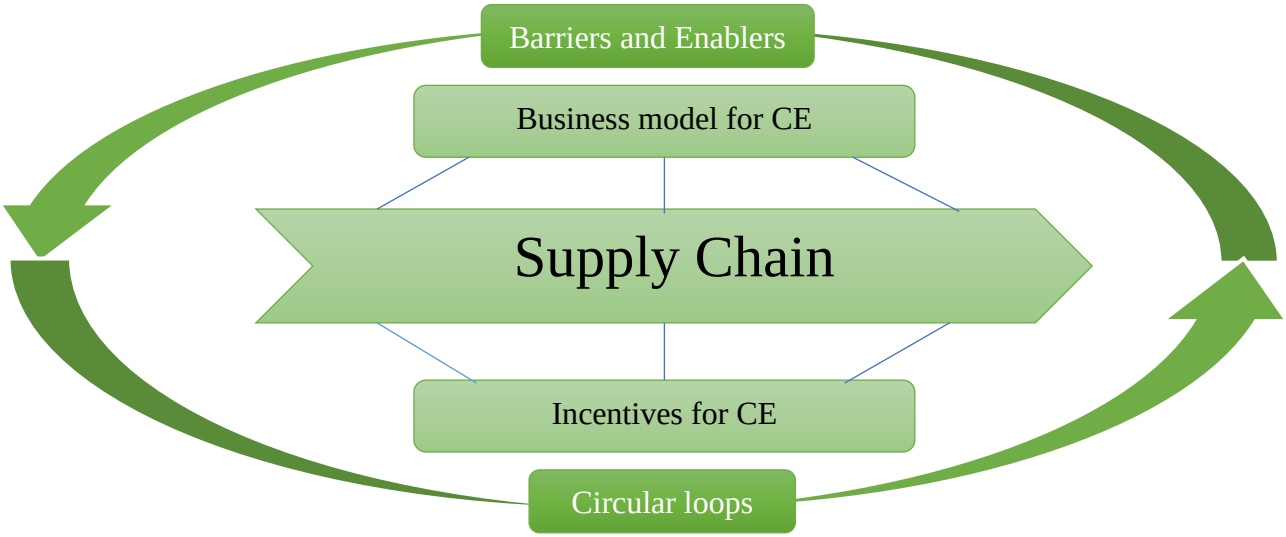

Figure 17: The Circular Supply Chain

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