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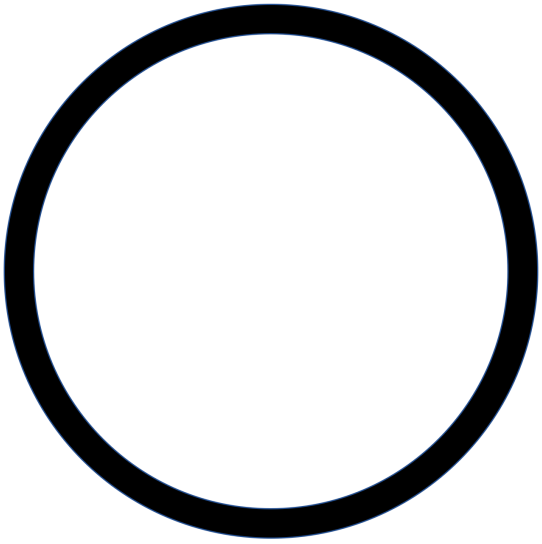

Investigating The Move Towards Circular Economy for Consumer and Retail Companies

How can PLM support circular business processes?

Master's thesis in the Master's Program Management and Economics of Innovation

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Gothenburg, Sweden 2017
Report No. E 2017:118

MASTER'S THESIS E 2017:118

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Chalmers Reproservice
Gothenburg, Sweden 2017

Foreword

The thesis was written at Chalmers University of Technology, at the department of Technology, Management and Economics, during 2017. The thesis constitutes 30 ECTS as a part of the Master Program Management and Economics of Innovation (120 ECTS). The report was conducted in collaboration with TechniaTranscat at the department of Consumer and Retail, Stockholm, Sweden. TechniaTranscat is an international supplier of Product Lifecycle Management systems and has over 4000 customers within equipment, automotive, construction, energy, telecom/electronics, life science, fashion and consumer goods (TechniaTranscat, 2017).

To introduce the importance of research about circular economy, some of the citations used in the thesis that explain researchers' and businesses' view on circular economy and the urgency of shifting towards it, are extracted below.

> 'Since the mid 1980s and with ever-increasing speed, environmental depletion has reached a global scale and scope where it actually starts to threaten the viability of our model of wealth creation itself. Our economy has grown so big, so fast, that it is quickly depleting the very same natural capital on which it thrives. In a way, it is falling victim to its own success.' (Stuchtey et. al, 2016, 11).

> 'Scientists argue we have entered the Anthropocene, a geological epoch where there are now so many of us, using so many resources that we are disrupting the whole planet's nutrient and energy flows leaving almost all the planet's ecosystems with marks of our presence.' (Stockholm Resilience Center, 2017).

> 'In a world with growing pressures on resources and the environment, the EU has no choice but to go for the transition to a resource-efficient and ultimately regenerative circular economy.' (European Commission, 2012, 1).

> 'The solution is to bring about a global shift from a linear to a circular system [...] This is the only way our industry will be able to operate to its fullest potential, while staying within our planet's boundaries.' (H&M Group, 2016, 36).

Acknowledgement

We would like to give a special thank you to our supervisors at TechniaTranscat, Alessandro Passaro and Hannes Lindfred. We could not have asked for more devoted and helpful tutors. All attention that has been directed to this report (Cradlenet's monthly news-letter, the most viewed blogpost at TechniaTranscat and several presentations) is thanks to them. The thesis happened because of their intrapreneurial initiative at TechniaTranscat and their entrepreneurial spirit inspired us to continue investigating the relatively new area of circular economy and all its possibilities during and after the thesis. Our (the author's) next step is starting a company together and our vision is to help spur the transition towards a circular economy. This study was the start of that journey. Therefore, we would also like to thank Alessandro and Hannes for introducing us to circular economy and teaching us how we can improve our future. We have tried our best to honor your effort through our work.

We would also like to thank our supervisor at Chalmers, Martin Wallin, for your support. You have given us great insight in how to write, structure and design the thesis. Without your valuable feedback, the report would not have looked the same.

In addition, we would like to thank all who participated in the study through interviews and/or feedback and input. We were sincerely happy for the interest shown towards participating and contributing. It gives us hope for a bright future that so many companies and people see the value of participating in a master thesis concerning a more sustainable future.

Stockholm, December 2017

Linn Lindfred  Isa Nordeld 

Abstract

Resources are getting increasingly scarce; the population is growing and the current linear model is reaching its physical limits. Also, the climate externalities are to a large extent caused by industries and the linear model. Circular economy rethinks the way we produce and consume and is focused on reuse, prolonging the lifetime of products, reducing the amount of waste and reducing the use of virgin resources through closing the loop of production and consumption.

The report answered the research question of how PLM systems could facilitate circular business processes. The research was of qualitative nature and the data in the study was collected through a literature review as well as through data gathered from the empirical research of multiple case studies. The multiple case studies were based on two data collecting methods; interviews and archives. The respondents were from two areas; individuals in charge of sustainability representing a company and experts within the field of circular economy and sustainability. Twelve companies all involved within textile took part in the study as well as eight experts. The interviews were of qualitative character and investigated how the business processes related to the product Lifecycle needed to change in order to become more circular and what tools, aids and information that is missing, in order to support circular business processes.

The study found that the most stressing issue was the lack of reliable sustainability information to base decisions on. In a circular scenario, the lack of information was depicted to result in problems in particular in the design phase and in the end-of-life phase. The consequence of not having the right reliable sustainability information in the design phase were outlined to be; uninformed decisions, lack of transparency, impeded circular design and lack of knowledge of environmental impact. The consequences in the end-of-life phase were; impeded circular design and lack of knowledge in how to handle the recollected products. The enablers that could improve the availability of sustainability information in these phases were analyzed to be; sustainability index, scorecards, and IT driven tags. However, it became evident that the move towards a circular economy also depends on several other enabling and supporting conditions. The additional barriers towards transitioning to a circular economy were found to be policies, changed consumer habits, culture in the company and change management, new measurements and KPIs, and investments and risk management.

Keywords: *Circular economy, linear economy, sustainability, PLM system, product Lifecycle, closed loop, product lifetime, birth-of-life, end-of-life, reverse logistics, reuse, barriers, enablers*.

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1. Introduction

The following section introduces the background, followed by a description of the problem initiating the thesis as well as the aim and the research questions that the thesis will answer.

1.1. Background

World Wildlife Fund (2012) writes that humanity each year uses renewable resources that require 1,5 planets. They claim that the global consumption needs to be in balance with the bio capacity. With this information, Carlsson-Kanyama and Gonzalèz's (2009) claim that our consumption and production patterns are killing our planet and depleting its resources, is not an exaggeration. Clinton (2013) states that our consumption patterns are the primary cause to the increased negative climate impact. The UN emphasized the same thing back in 1992, that the pattern of consumption and production is unsustainable, being the major cause of the deterioration of the global environment. The Official Reports of the Swedish Government writes that only one third of the negative climate impact derives from handling fossil fuels, and the remaining part is a result from handling other materials (SOU 2017:22). On this note, Holmgren (2014) argues that the impact humans have on other species and the ecosystem is now bigger than ever before. The acuteness of the sustainability issue is depicted from the increasing number of environmental laws and legislations. The Ellen MacArthur Foundation[1] (2015a) finds that the number of climate change laws increased by 66 per cent between 2009-2012.

The dominating way of producing and selling goods, from industrialization until today, is the linear economic model also called the take-make-dispose model (Ellen MacArthur Foundation, 2015a). It means that resources are extracted as cheaply as possible, transformed into goods, and disposed (ibid). The linear model takes little consideration of the waste and pollution generated, nor of the extraction of the decreasing finite resources (Sauvé et al., 2016; Ellen MacArthur Foundation, 2015a). The challenges of today's linear economy are according to The Ellen MacArthur Foundation (2015a); (1) natural systems degradation - climate change, loss of biodiversity, loss of natural capital, land degradation, ocean pollution, (2) price risk - the price instability of resources increases, (3) supply risk - the increased amount of imported goods increases risks to the supply of raw materials, safety and security in the supply chains.

The environmental threats have given rise to a debate concerning new ways of conducting business in a sustainable way. The circular economy is an economic model that rethinks the

[1] The Ellen MacArthur Foundation works with business, government and academia to build a framework for a circular economy and is the global thought leader for accelerating the transition (Ellen MacArthur Foundation, 2017). The charity started in 2010 and is supported by SUN and MAVA (ibid). They partner with Arup, IDEO, McKinsey & Company and SYSTEMIQ (ibid).

business processes and economic models (TU Delft, 2017; World Economic Forum et. al., 2014). The Ellen MacArthur Foundation (2015a) argues that the environmental efforts in today's linear economic models, where the focus is on reducing resources and fossil energy consumed per unit of economic output, is not a sustainable solution for overcoming the threat of decreasing finite resources. They mean that the environmental efforts in the linear model only extends the process of emptying resources whereas instead, the circular economy moves away from the linear open model towards a circular closed loop model.

The Ellen MacArthur Foundation et. al (2015) define circular economy as a model that is restorative and regenerative by design. The Circular Economy moves away from the dependency on finite resources, enabling closed loops of the product Lifecycles (Sauvé et al., 2016; Ellen MacArthur Foundation et. al., 2015). It thus focuses on producing long lasting products made to be easily repaired, disassembled and recycled, replacing the fast and cheap production and disposal characterizing the linear economic model (ibid). Pollard et al. (2016) summarize circular economy as a concept that, instead of preventing harm, urges to rethink and redefine the system.

This new economic model has gained traction in higher education. TU Delft (2017) explains in their course; Circular Economy, An Introduction (2017) the concept of circular economy as a make/remake-use/reuse economy, meaning that the model recovers and reuses the products and materials to the widest extent possible. The increasing interest in circular economy fosters discussions of the transitions from linear to circular ways of doing business. Several researchers have depicted issues and hinders of moving towards more circularity (Bechtel et. Al (2013); Bocken et. al (2013); Ellen MacArthur Foundation et al. 2015; Zhijun and Nailing, 2007). The findings show that there is a need for tools, methods and aids that will facilitate and enable transitions (ibid).

According to The Ellen MacArthur Foundation (2015b), the transition towards a circular economy is sped up by technology such as; (1) smartphones - enables sharing services such as Uber, (2) Internet of Things - enables an increased interconnectedness, tracking efficiency and predictive maintenance (3) advanced manufacturing and processing technologies - enables circular operations at lower costs (4) decreasing costs of renewable energy. All these technologies enable the shift towards a circular economy (ibid). The use of technology when transitioning to a circular economy is necessary to reach a successful outcome since it can result in more efficient collaboration, knowledge/information sharing as well as improved and faster tracking of materials (ibid).

The link between technology and circular economy is further highlighted in research where the use of IT systems, such as Enterprise Resource Planning (ERP) systems and Product Lifecycle Management (PLM) systems, is seen as an effective way of keeping track of materials, products, knowledge, information, and communication, as is required from circular processes (Zhijun & Nailing, 2007). PLM systems manage the processes within the product Lifecycle and provide information about the product in the phases of the Lifecycle, such as its

material and information flows (Stark, 2015). The closed loop PLM system's vision is to enhance the information flows and transparency and involve larger parts of the product Lifecycle (Jun et al., 2007). It is still unknown exactly how PLM can facilitate circular processes due to the low number of cases to study.

1.2. Problem Identification

The environmental impact is largely due to the economic growth and high standards of living that characterizes large parts of the world (Rockström et al. 2009; Clinton, 2013; SOU 2017:22). The implications are a result of the economic models of the neoclassical markets that has been dominating the last centuries (Stuchtey et al., 2016; World Wildlife Fund, 2016). The acute need for changing the way resources are used and taken care of, has in latter years given rise to an ongoing sustainability debate focused on new business models that rethinks the business processes and economic models as they are today (Stuchtey et al., 2016; TU Delft, 2017; Ellen MacArthur Foundation, 2015a). Changing the linear model that is open-ended into a circular one that has closed loops, has the potential of stopping the emptying of the finite resources while focusing on reusing, regenerating and eliminating waste (World Economic Forum et al., 2014; Ellen MacArthur Foundation, 2015a). The circular model then not only prolongs the descendance of finite resources, as has historically been the result from sustainability actions within the linear model, but proactively finds ways to deviate from the need of these resources (Ellen MacArthur Foundation, 2015a).

Moving towards a circular economy implies changing strategies, business models and systems which in turn requires changes within the firm and thus affected business functions and processes (Lieder & Rashid, 2015; Ellen MacArthur Foundation et al., 2015). Researchers have depicted what obstacles businesses meet when moving towards a circular economy as well as what business functions and processes are affected by the transition and how (Lieder & Rashid, 2015; Ellen MacArthur Foundation et. al., 2015; Bechtel et. al., 2013; Jacono, 2013; Zhijun & Nailing, 2007). However, there is a need for further investigation on how to solve problems that occur when moving towards circularity; when prolonging the product lifetimes, reusing, remanufacturing, recycling and minimizing waste (Becthel et. al., 2013; Zhijun & Nailing, 2007). There is also a need for finding ways to facilitate the transitions towards more circular processes and thus enable the shift (Zhijun & Nailing, 2007).

Based on the above reasoning, the need of changing the way we take, make and dispose our resources is substantial but the move towards a circular economy intra-firm requires solutions that enable the transition (Bechtel et. al., 2013; Ellen MacArthur Foundation et al. 2015; Zhijun & Nailing, 2007). In order to enable the shift, the use of technology is necessary (Ellen MacArthur Foundation, 2015b). However, the novelty of circular economy, the small number of companies that have gone circular together with the currently ongoing technology revolution imply there is a lack of research in how, and in what ways technology and circular economy can create value together.

One technology, the PLM system, can provide information about the product in the phases of the Lifecycle, such as its material and information flows (Stark, 2015). PLM is today used in linear companies' businesses in order to facilitate the product Lifecycle processes but with circular economy follows new demands of information and transparency. It could be argued that PLM could be a critical tool to use when these processes change into circular ones. Stark (2015) claims that a PLM system trains the user to see the whole Lifecycle of a product. In the design phase, the user can also take in consideration of how the product will be manufactured, disassembled and recycled (Stark, 2015). Lieder and Rashid (2015) think that PLM could enable circular processes. They believe that ICT has the potential to enable the PLM system to incorporate products and parts in multiple Lifecycles. The so called Closed Loop PLM tries to answer to the increased transparency demands characterizing circular processes but it is still unknown what kind of information is necessary to incorporate into such PLM systems.

1.3. Purpose and Research Question

Through conducting interviews with companies within the consumer and retail industry as well as with experts in circular economy, the thesis investigates how the business processes related to the product Lifecycle need to change in order to become more circular and what tools, aids and information that is missing today, in order to enable circular business processes. Based on this, the thesis examines if, and in what way, these demands and changes might be answered to, or facilitated by, a Product Lifecycle Management (PLM) system, in the consumer and retail industry. Thereby, the research question is;

- *How can PLM systems facilitate circular business processes?*

2. Theoretical Framework

The following section aims to give an understanding of the concept of circular economy, from its origin to its potential. The chapter describes in detail, the background of circular economy, why and from where the concept originated, what the concept and the transition means, the barriers related to the transition, as well as the benefits of switching to more circular models. The theoretical framework takes on a rather general approach of the concept and its applications but one section is focused to circular economy in the fashion and textile industry, providing a background to the interviewed companies. After introducing the circular economy, the Product Lifecycle Management (PLM) system is described, where after it is presented how IT and circular economy could create value together.

2.1. The Stressing Issues of The Linear Economy

Since industrialization until today, the economic model of the global industrial setting has been based on the same processes; extracting resources and disposing of them after use, defining the open ended linear economy (Andersen, 2007; World Economic Forum et al., 2014; Stuchtey et al., 2016). There is no doubt that the linear economy is prosperous in terms of industrial and economic growth, considering the many people that have risen from poverty as well as the GDP measure which has increased from 23 trillion Euros in 1990 to 78 trillion Euros in 2015 (Stuchtey et al., 2016). However, the negative externalities of the consumption and manufacturing are becoming increasingly prominent (World Wildlife Fund, 2016).

The most obvious proof of our unsustainable lifestyle is seen in the current environmental impact. The impact of human's way of living has been identified in a framework called The Nine Planetary Boundaries Framework (Rockström et al., 2009). The concept was first described in 2009, developed by 28 renowned scientists within the earth system- and environment field (ibid). The Nine Planetary Boundaries Framework considers the functioning of the earth system and identifies the safe operating space for humans (ibid). Overstepping the boundaries could result in global environmental change, possibly irreversible (ibid). The scientists Rockström et al. (2009) argue that crossing the boundaries could be catastrophic. The nine boundaries are presented in figure 2.1. The most recent research on this topic, presented in the journal, Science (2015), shows that four out of nine boundaries are overstepped, that is boundaries; 1. Climate change, 2. Loss in biosphere integrity, 5. Altered biogeochemical cycles and 6. Land system change (Steffen et al., 2015). On this note, The Stockholm Resilience Center writes on their webpage:

> 'Scientists argue we have entered the Anthropocene, a geological epoch where there are now so many of us, using so many resources that we are disrupting the whole planet's nutrient and energy flows leaving almost all the planet's ecosystems with marks of our presence.'. (Stockholm Resilience Center & Stockholm University, 2017).

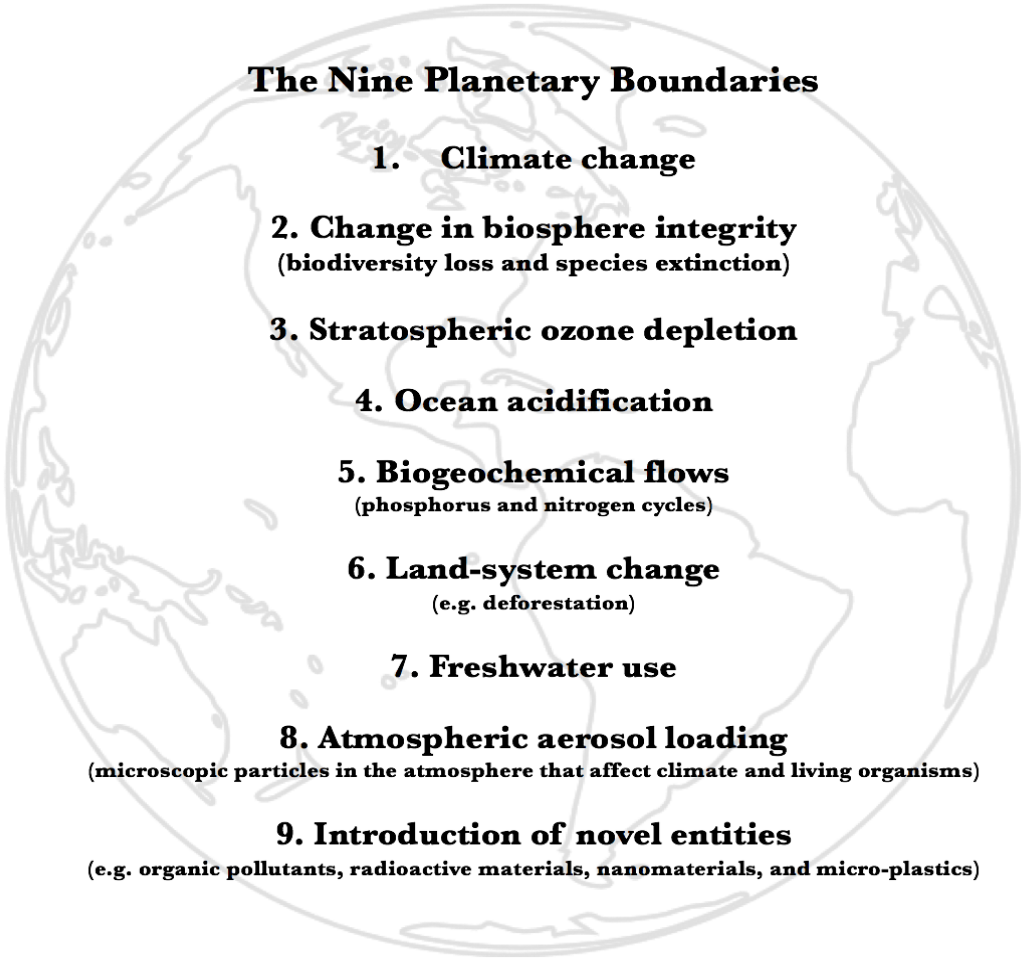

Figure 2.1. The Nine Planetary Boundaries by Rockström et.al., (2009). The nine boundaries define the safe operating space for humans (ibid).

While the impact on our planet is a fact that has been on politicians' and businesses' agenda for several years, it has historically been tackled with the aim to achieve balance among the three pillars of sustainability; the Economic, Social and Ecological perspective, making up the so-called sustainability triangle or The Triple Bottom Line, also called People, Planet, Profit (Circular Ecology, 2016). Figure 2.2 illustrates The Triple Bottom Line. Ecological Sustainability - Planet, denotes the consumption of natural resources at a sustainable rate, The Economic Sustainability - Profit, relates to efficient and responsible resource use for a sustainable and profitable operation and The Social Sustainability - People considers maintaining social well-being (ibid).

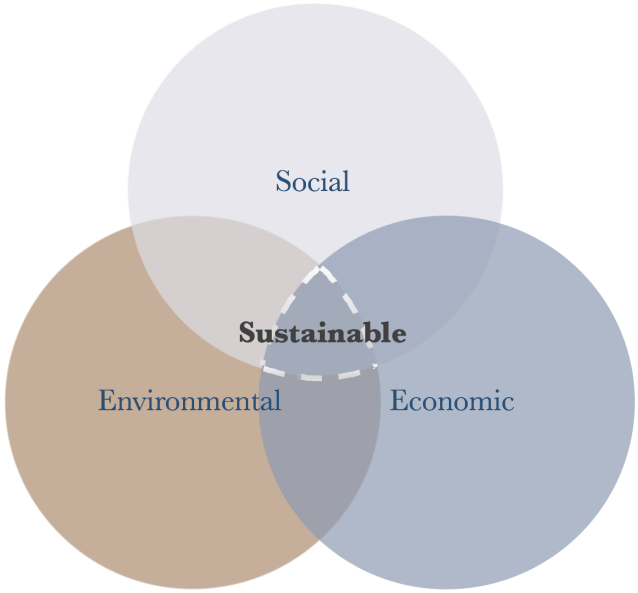

Figure 1.2. The figure illustrates the three pillars of sustainability, The Triple Bottom Line. The figure is illustrated from Circular Ecology (2016).

Cradle to Cradle Products Innovation Institute[2] (2014) writes that historically, when companies try to balance The Triple Bottom Line, it oftentimes results in business strategies solely focusing on minimizing environmental or social liabilities. Thus, strategies for handling the negative effects (ibid). Similarly, the former McKinsey consultants Stuchtey et al. (2016) mean that merely making changes within the current linear model will not be nearly sufficient in terms of reaching enough impact. In their book about circular economy called A Good Disruption, they write that the issues within the global ecosystem are becoming more and more prominent and that the society is leaving the safe operating space which they mean is resulting in profound consequences for this generation and the next to come (ibid). Besides the environmental impact of the current industrial setting, the authors also emphasize the obvious diminishing returns of the linear model. They state that:

> 'Since the mid 1980s and with ever-increasing speed, environmental depletion has reached a global scale and scope where it actually starts to threaten the viability of our model of wealth creation itself. Our economy has grown so big, so fast, that it is quickly depleting the very same natural capital on which it thrives. In a way, it is falling victim to its own success.' (Stuchtey et al., 2016, 11).

The authors argue that a redesign in how resources are used in the world economies is not a suggestion but a necessity. They mean that the linear model, focused on transforming natural capital, desperately needs to change. Similarly, the diminishing returns of the current linear

[2] Cradle to Cradle Product Innovation Institute is a non-profit organization for educating product manufacturers and designers to make safe and healthy products and become a positive force for society and the environment (C2C-Centre, 2017a).

model is also something World Economic Forum et al. highlight in a report from 2014. They state that the current linear model is exposed to volatility and price risks and refer to the increased prices of resources as well as the supply disruptions that has categorized the economy in the latter years. During 2000 until 2013, the price of natural resources has increased significantly, in comparison to the time period of 1900 until 2000, where there was a price decrease (World Economic Forum et.al., 2014). At the same time, World Economic Forum et al. denote that in 2010, 65 billion tons of raw materials were input in the linear economy and in 2020 the amount of raw materials is expected to increase to 82 billion tons. In addition to this, the report finds that the population will increase and urbanize; in 2030, 3 billion new middle-class consumers are predicted to evolve. With this background, the same report concludes that the high prices and volatility that can already be seen in the current economy will increase.

Moreover, the potential of increasing the efficiency of manufacturing processes in the linear economy is decreasing and so is also the potential to gain a competitive advantage from these actions (World Economic Forum et al., 2014). Thus, the abovementioned facts are presented to be the reason for the current search for a new industrial setting, something Kopnina (2017) agrees with when arguing that businesses need to understand that achieving sustainability today requires changed business models. She says that the current population growth, consumption behavior and stressing environmental issues call for changed business models.

2.2. What is The Circular Economy?

As a solution to the abovementioned stressing issues, a new way of conducting business has emerged called the circular economy. This new wave of sustainability is seen as disrupting the current linear model, according to Stuchtey et al. (2016). Pollard et al. (2016) agree and mean that historically, the sustainability efforts of the open-ended linear model has been to prevent harm, when instead the closed system of circular economy urges to creatively rethink it. Figure 2.3. presents how the circular model closes the loop in comparison to the linear model.

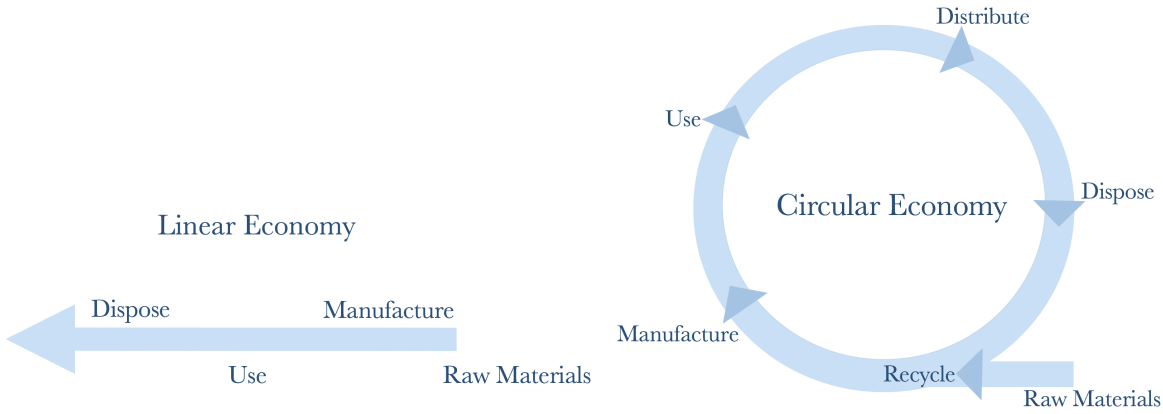

Figure 2.3. The figure illustrates the linear open model and the circular closed loop model, based on the descriptions of circular economy and linear economy by Pollard et al. (2016), TU Delft (2017), Ellen MacArthur Foundation (2015a).

The cornerstone of a circular economy is prolonging the lifetime of products and the course Circular Economy, An Introduction (2017), Delft University of Technology, (henceforth referred to as TU Delft (2017)), explains how extending the lifetime is achieved in a circular scenario. They state that it can be done in two ways; either through using the product for longer or giving the product a new life. They explain the circular economy as using resources but also retaining them in continuous feedback loops. Thus, they mean that the lifetime of products can be extended through looping the products as many times as possible by finding new value streams for the products and/or its components. This is further explained by The Ellen MacArthur Foundation (2015a) as constantly keeping materials and products at their highest utility and value. The Ellen MacArthur Foundation (2015a) describes that this is done through looping the products in both technical and biological Lifecycles. The biological cycle is the flow of renewable resources and the technical cycle is the flow of finite resources, see figure 2.4 (ibid). The technical cycle involves prolonging the products' lifetimes through either maintenance, recovering, restoring, remanufacturing or recycling whereas the biological cycle regenerates and consumes renewable resources, like the natural system degradation (ibid). This is done through anaerobic digestion, biochemical feedstock or natural restoration (ibid).

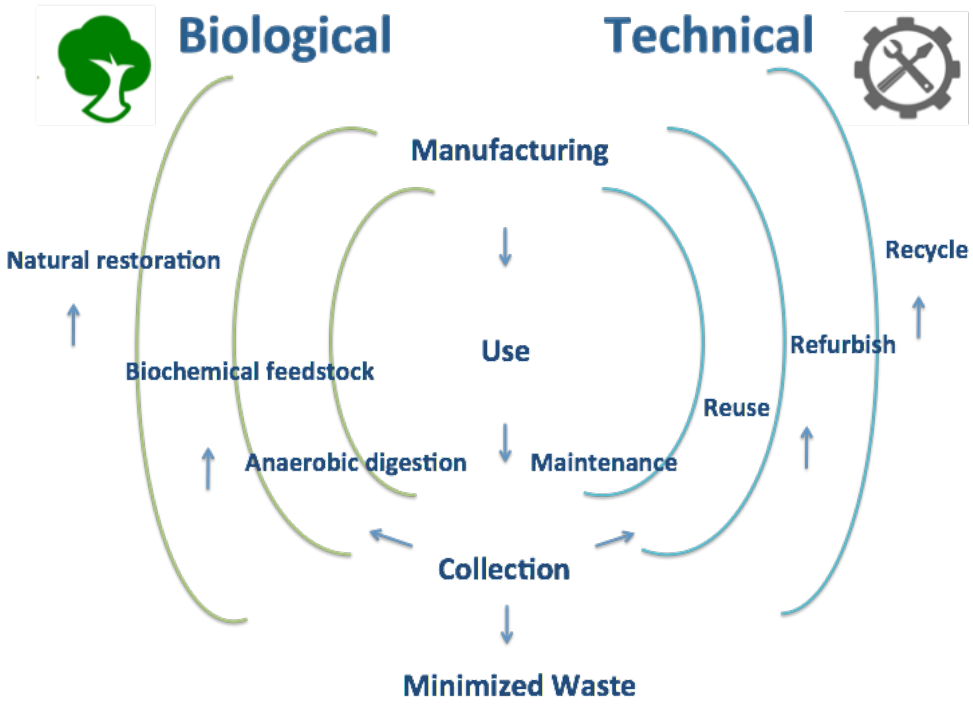

Figure 2.2. The figure illustrates the biological and technical Lifecycles in a circular economy, based on the picture on page 6 in the report Towards a Circular Economy: Business Rationale for an Accelerated Transition by The Ellen MacArthur Foundation (2015a, 6).

How to constantly keep products, materials and components at their highest utility and value, thus prolonging the lifetimes, is further discussed by TU Delft (2017). They state that there is a greater profitability if the loop is smaller, see figure 2.5. Stahel (2016) elaborates on this when he says that it is necessary to; '…replace production with sufficiency; reuse what you can, recycle what cannot be reused, repair what is broken, remanufacture what cannot be repaired.' (Stahel, 2016, 1). Stahel (2016), The Ellen MacArthur Foundation (2015a) and TU Delft (2017) all mean that the product lifetimes need prolonging, and that it can most effectively and most economically be achieved through reintroducing the product into the loop that requires the least change to the existing product. In figure 2.5. this is denoted by Life Extension. They mean that the faster it is returned to reuse, the more saving in terms of material, labor, energy and capital can be achieved, as well as the more negative externalities can be saved. The Ellen MacArthur Foundation (2015a, 8) refers to this as, '...the tighter the circle, the more valuable the strategy.'.

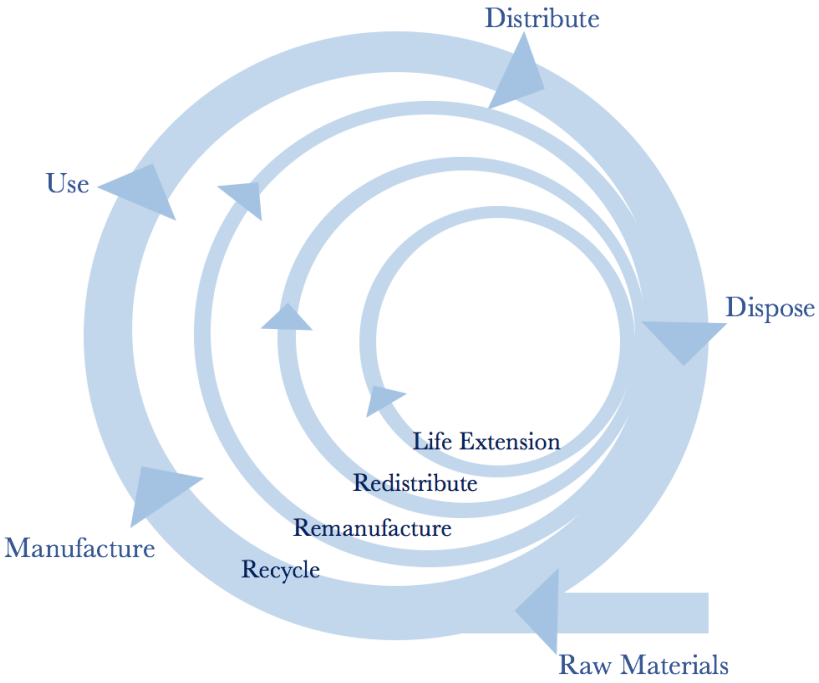

Figure 2.3. The figure shows the loops of circular economy with the most profitable loop denoted by the closed loop in the middle, Life Extension. The picture is based on The Inertia Principle by Stahel (2016) as well as from the above descriptions by TU Delft (2017) and The Ellen MacArthur Foundation (2015a).

Stahel (2016) further explains this by using the analogy of a glass bottle; he means that cleaning the bottle and reusing it is both a faster and a cheaper option than recycling or producing a new bottle. Stahel calls this the Inertia Principle. The Inertia Principle means that the business models of the circular economy are divided into two areas; either they focus on extending the lifetime of the products by reusing them through repairs or remanufacturing, or they focus on turning used products into as-new resources by recycling (Stahel, 2016). This way of thinking is also in line with the hierarchy of waste (IVL Swedish Environmental Institute, 2017). The hierarchy of waste is a framework aiming to guide waste management in how to work in the most efficient and effectual way (ibid). The hierarchy of waste is illustrated in figure 2.6. The hierarchy states that avoiding generating waste is the first priority, followed by reuse, then recycling, thereafter energy recovery and finally landfill (ibid). As abovementioned, in a circular economy the focus is on preventing and minimizing waste through circular designs and reuse, before recycling, energy recovery and landfill (IVL Swedish Environmental Institute, 2017; Stahel, 2016; TU Delft, 2017; Ellen MacArthur Foundation (2015a); Zhijun & Nailing, 2007).

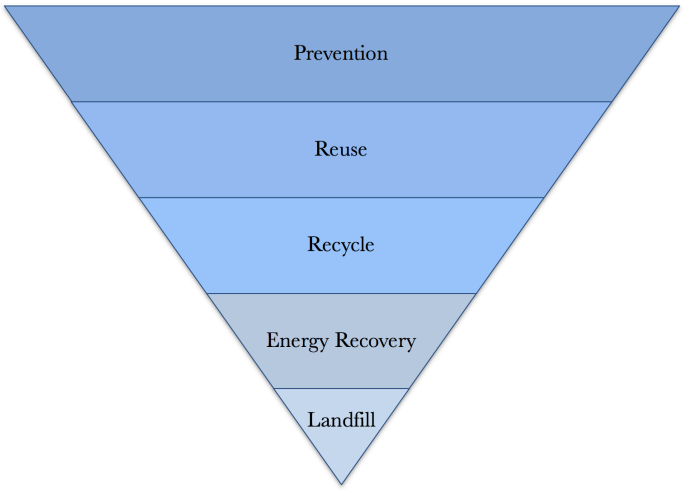

Figure 2.4. The figure is illustrated from EPA (2017) and illustrates the waste hierarchy with the most prioritized way of handling waste presented at the top (prevention) and the least prioritized way presented at the bottom (landfill).

In order to explain the concept of circular economy, it is necessary to explain its origin. The concept of circular economy has emerged from former ideas and academic disciplines within sustainability such as industrial ecology, cradle-to-cradle and biomimicry (TU Delft, 2017). Figure 2.7 describes the concepts in short.

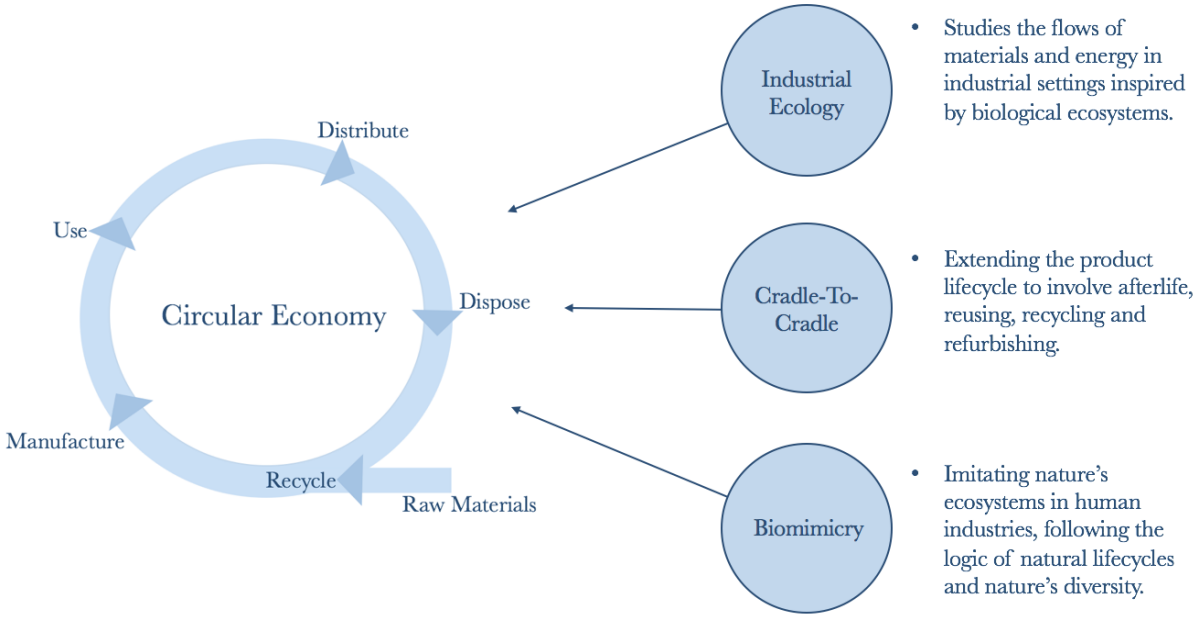

Figure 2.5. The figure describes three concepts; cradle-to-cradle, industrial ecology and biomimicry, which all inspired the discipline of circular economy to emerge. The descriptions are interpreted from the sources described in the below text (TU Delft, 2017; Allenby & Richards, 1994; Yale University, 2017; Lowe & Evans, Benyus, 1997; Biomimicry Institue, 2017).

To explain in more detail, industrial ecology refers to the flows of material and energy through industrial systems (TU Delft, 2017). Allenby and Richards (1994) define industrial ecology as;

> 'Industrial ecology is the study of the flows of materials and energy in industrial and consumer activities, of the effects of these flows on the environment, and of the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources' (Allenby & Richards 1994, 5).

Industrial ecology is inspired by biological ecosystems that are effective at recycling and base industrial activity on non-human biological ecosystems (Yale University, 2017). In this way, just like waste in nature becomes reincarnated and upcycled into new products, the concept of industrial ecosystems describes that the waste from one production should become input to another (Lowe & Evans, 1995). Many industrial ecologists refer to the concept being initiated as early as in 1969 (Yale University, 2017). According to TU Delft (2017) the difference between industrial ecology and circular economy is that the former is more of an academic field and the latter is to a larger extent about business and economy.

Moreover, the circular economy has roots in the concept of cradle-to-cradle. Cradle-to-cradle was invented by Walter R Stahel in 1970 (TU Delft, 2017). In order to explain the concept, it is necessary to explain the product's lifetime and Lifecycle. The lifetime of a product in the linear ways of conducting business is usually denoted to the birth until end-of-life (disposal) of a product, describing the cradle-to-grave cycle (Kopnina, 2017). According to Kopnina (2017) the concept of cradle-to-grave is used in the business setting describing how companies take care of their waste, i.e. how they deal with hazardous waste and product performance. However, in a circular economy scenario, the Lifecycle extends to also involve the after-life of a product, thus the reusing, refurbishing or recycling which denotes the cradle-to-cradle cycle (TU Delft, 2017). Cradle-to-cradle describes the process of making waste-free production which means that the input can be either recycled or reused, without impeding the quality (TU Delft, 2017).

Circular economy also stems from the concept of biomimicry (Circle Economy, 2017a). Biomimicry means imitating the way of nature, i.e. following the logic of natural Lifecycles and nature's diversity (Benyus, 1997). The biomimicry sees nature's ecosystems as complex societies of living things, part of the circle of life and adapted to the surroundings (Benyus, 1997; TU Delft, 2017). Biomimicry means imitating these ecosystems in human industries and thus learning from nature's way of doing things (ibid). The Biomimicry Institute (2017) defines the concept as: 'An approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies.'.

Even though circular economy stems from other disciplines, the concept in itself is according to several researchers complex to communicate in a correct and understandable way (TU

Delft, 2017). Different researchers thus explain circular economy in slightly various ways. Therefore, different researchers' explanations of the concept are here presented. To begin with, Zhijun and Nailing use one definition of circular economy in Sustainable Science (2007), see figure 2.8. They write that circular economy can be built on three principles; (1) reducing resource use - minimizing the use of raw materials and energy as well as decreasing pollution, (2) reusing - using the product for other applications after its original consumption and in that way, avoid waste, and (3) recycling - using the product many times.

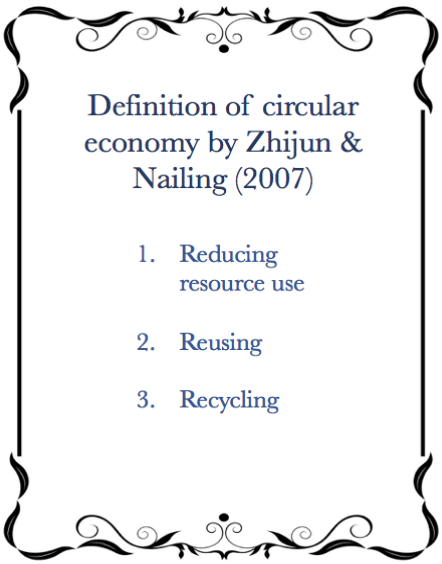

Figure 2.6. The figure presents Zhijun and Nailing's (2007) definition of a circular economy.

Another definition by TU Delft (2017), instead base the concept on four foundations, see figure 2.9. (1) Waste equals food - waste can and should be turned into value, (2) Build resilience through diversity - a greater biodiversity supports a system and enables greater resilience, (3) Using energy from renewable sources, (4) Think in systems - see all possible connections such as those between business, people and plants and thus create opportunities.

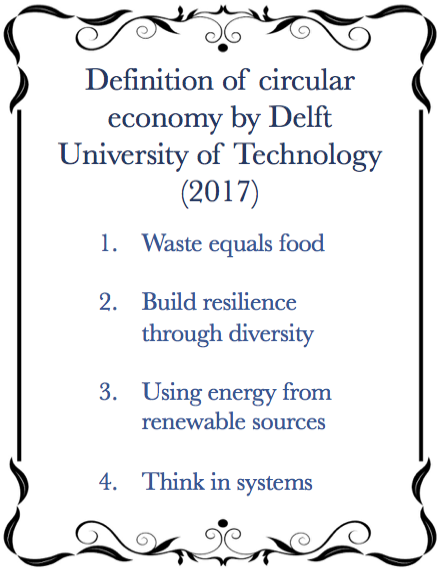

Figure 2.7. The figure presents TU Delft's definition of circular economy presented in their course Circular Economy, An Introduction (2017).

Moreover, The Ellen MacArthur Foundation (2015a) which is the global thought leader for accelerating the transition towards a circular economy, explains the circular economy in another way, through three principles; see figure 2.10. (1) Preserve and Enhance Natural Capital - minimize the use of finite resources and increase the use of renewable resources, (2) Optimize The Resources' value - loop products, components and materials and keep them at '...their highest utility at all times in both technical and biological Lifecycles.' (Ellen MacArthur Foundation, 2015a, 7), (3) Nurture Effective Systems - eliminate negative externalities like water, air, soil, toxins, climate change and negative health effects related to resource use.

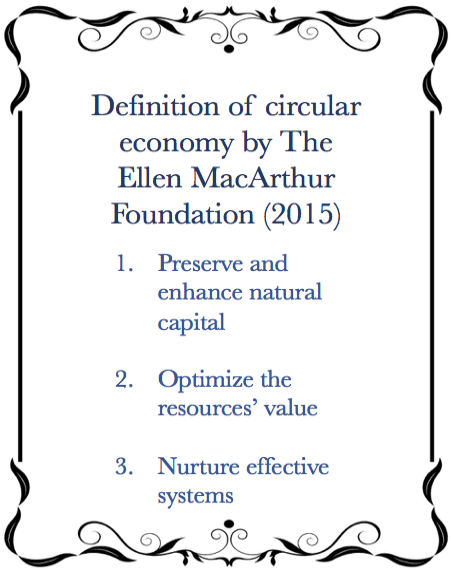

Figure 2.8. The figure presents The Ellen MacArthur Foundation's (2015a) definition of circular economy.

2.3. Circular Economy in Business and Society

As circular economy gains ground, with it comes both opportunities and benefits but also implications and hinders. The following chapter explains the positive and negative implications of the transition first in a wide perspective and thereafter focused to the textile and fashion industry.

2.3.1. Circular Economy is Gaining Traction

The concept of circular economy started to be discussed in the late 1970s but has gained traction substantially in the latter years (Ellen MacArthur Foundation, 2017). Today, it is a prioritized question in many countries (ibid). In 2015, The European Commission released its Circular Economy Package describing their vision of how Europe could shift towards a more circular economy, with the background of the following quotation;

> 'In a world with growing pressures on resources and the environment, the EU has no choice but to go for the transition to a resource-efficient and ultimately regenerative circular economy.' (European Commission, 2012, 1).

The Circular Economy Package includes an action plan for the circular economy and legislative proposal on waste policy (European Commission, 2017). The EU action plan for the circular economy aims to enable organizations to close the loop of their products' Lifecycles through better recycling and reuse (ibid). The legislative proposal on waste includes targets in 2030; recycle 65 per cent of municipal waste, 75 per cent of packaging waste, reduce landfill to maximum 10 per cent of municipal waste (ibid). Furthermore, the proposal bans landfill of separately collected waste, wants to increase economic incentives for companies to sell greener products and support recycling, and aims to create concrete measures for recycling rates and for stimulating one industry's by-product to be another industry's raw material (ibid).

The Swedish Government is also investigating the transition towards a more circular economy. The Official Reports of The Swedish Government describe the circular economy as a cycle of materials, products and services where we do more with less (SOU 2017:22). The Government call it a smarter economy where the lifetimes of products and materials are longer and the amount of waste and use of resources are decreased through reusing, restoring, recycling, upgrading, renting and sharing. In 2017, The Swedish Government presented their investigation of the circular economy potential for Sweden (SOU 2017:22). Several regulations and subventions were proposed that would favor circular processes such as closer collaboration between environmental policy and industrial policy, increased availability of car pools as well as possibilities for municipality to regulate towards more resource-efficient procurement (ibid).

Apart from gaining traction in the political sphere, circular economy has successfully been introduced into several companies' long term strategies and business models (Ellen MacArthur foundation et al., 2015). Two of the biggest retail companies in Sweden and globally, H&M and IKEA, are in the forefront of incorporating circular processes in their business (H&M, 2016; IKEA, 2015). In H&M's sustainability report 2016, it can be read that;

> 'The solution is to bring about a global shift from a linear to a circular system… This is the only way our industry will be able to operate to its fullest potential, while staying within our planet's boundaries.'. (H&M, 2016, 36).

2.3.2. A Complex Transition

Bocken et al. (2013) claim that difficulties and obstacles follow the new circular processes since there is insufficient information of how to make the transition. Several researchers have investigated the barriers towards a circular economy and the barriers range from, for example; policy barriers, change management barriers to technological barriers (Zhijun and Nailing, 2007; Bechtel et al., 2013; Ellen MacArthur Foundation, 2015b). A study by Bechtel et al. (2013), which investigates the barriers and enablers for a circular economy among Small and Medium Enterprises, found that change management, lack of capital, time and investment, lack of government support, lack of information about the concept of circular economy, lack of an information exchange system, too heavy administrative burden of green business practices i.e. the long and complex procedures of attaining certifications and meeting standards, lack of technical and technological know-how were the most obvious barriers towards the transition.

Furthermore, the same study showed that out of 9 interviewed global companies and 18 academic experts, the most commonly mentioned barrier to a circular economy was the technological barrier based on 165 barriers in total. The technological barrier for example included specific technologies for recycling as well as technologies for processes such as product design (ibid). The report also finds that there is generally a lack of design specifications on how to design for circularity, thus design for reuse, remanufacturing and recycling. The study shows that in order to transition to a circular economy, it is necessary to transform business-as-usual operations which in turn requires new sustainable production and consumption technologies. The authors refer to the areas of eco-design, clean production and Lifecycle Assessment, that they mean need to be integrated within the current business models. They further argue that lack of technical know-how might mean that the businesses only adopt the familiar linear technologies and business models.

The Ellen MacArthur Foundation et al. (2015) say that in order to switch to a circular economy, there are several enabling conditions that can facilitate the switch. These are in the report depicted to be (1) Education - creating the needed skills, (2) Financing - capital and risk assessment that can be enabled by governments underwriting risks with new business models, (3) Collaborative Platforms - enabling collaboration across the chains and across sectors as

well as (4) IT - enabling transparency and information sharing. Further, the report argues that a new economic framework which changes the existing measurements of economic performance will facilitate the move. This is also discussed in Stuchtey et al.'s (2016) book A Good Disruption. The authors argue that it is necessary to not only base decisions on short-term performance measure and GDP. They argue that a narrow focus on short-term goals will impede the companies' abilities to create long-term value for all stakeholders. They mean that new metrics are needed in order to steer organizations on the right course. They furthermore argue that new measurements for evaluating operations, such as measuring systemic risks, the quality of capital and people, their role in society and their ability to renewal themselves, are necessary as well.

2.3.2. Benefits of Circular Economy for Industry and Society

Through utilizing the circular model in favor of the linear, the take-make-dispose mantra can be disposed of and replaced with the make/remake use/reuse philosophy. Doing so is predicted to result in several benefits for businesses and the society; The Ellen MacArthur Foundation et al. (2015) have shown that the circular economy generates economic growth, creates jobs, reduces environmental impacts, foster industrial renewal and can achieve benefits such as a more innovative and productive economy. Also, The Official Reports of the Swedish Government writes that the circular economy creates possibilities for growth and new types of jobs and businesses around the world (SOU 2017:22). The report published by World Economic Forum et al. (2014) also presents the economic and business benefits of moving to a circular economy. They imply that the benefits of a circular economy are both economic and strategic. The investigation shows that;

> 'Economies will benefit from substantial net material savings, mitigation of volatility and supply risks, drivers for innovation and job creation, improved land productivity and soil health, and long-term resilience of the economy.' (World Economic Forum et al., 2014, 18).

It is further presented by the same report that circular economy will lead to increased wealth and employment due to resource constraints (World Economic Forum et al., 2014). The investigation finds that circular economy creates more value from each specific resource than the linear model does, and through eliminating waste; production cost savings and less resource dependence is achieved. These yearly material savings are in the report calculated to exceed a trillion dollars. Furthermore, circular economy will result in increased land productivity and soil health due to less waste and the return of nutrients to the soil (World Economic Forum et al., 2014). The cost for land degradation is estimated to exceed 40 billion US dollars each year globally (ibid). In addition, circular economy is predicted to increase the creative solutions and spur innovation, which World Economic Forum et al. (2014) mean will contribute to the long resilience of the economy.

In the report Intelligent Assets by The Ellen MacArthur Foundation (2016), it can be read that the manufacturing industry offers one of the biggest potentials in terms of having an economic and environmental impact. The report means that manufacturing has been examined by circular economy studies for years and it bears the potential of saving materials worth USD 630 billion in the EU in an advanced circular economy scenario. The Ellen MacArthur Foundation et al. (2015) lists profit opportunities for companies with complex medium-lived products and fast moving consumer goods, for going circular. As an example, mobile companies that encourage customers to return their phones, make them easier to disassemble and improve the reverse cycle, can lower the cost for remanufacturing by 50 per cent per device. In a similar manner, manufacturers of high-end washing machines could increase profits by a third by leasing instead of selling (Ellen MacArthur Foundation et al., 2015). In this way, they reach a wider customer segment and customers pay less for each wash (ibid).

As the most polluting manufacturing industry, the fashion and textile industry is predicted to have huge potential going circular. A study by The Ellen MacArthur Foundation et al. (2015) shows that reuse opportunities for the clothing industry in the U.K. could lead to a revenue of USD 1,97538 – or a gross profit of USD 1,295 per ton of sorted and collected clothing.

2.3.3. The Transition in The Fashion and Textile Sector

The urgency of changing the fashion industry is emphasized in The Impact Report 2013-2016 by H&M Foundation[3] (2017c). The report presents the H&M Foundation's work during 2013 until 2016 and states that:

> 'With a total value of USD 3 trillion, the global fashion industry has a huge environmental responsibility. In order to create a sustainable future, it's impossible to go on shipping, selling and consuming clothes in a linear mode.' (H&M Foundation, 2017c, 34).

The Circle Textiles Program[4] states that the processes within fashion rely heavily on non-renewable resources such as water, land and energy (Circle Economy, 2017a). Conca writes in Forbes (2015) that the apparel industry comes second place after the oil industry as the most polluting industry in the world. TU Delft (2017) says that in the manufacturing process of the fashion industry, 15 percent of the fabric used is wasted and a third of the produced products cannot be sold. They state that a strong case of non-circularity is that some fashion companies destroy their garments deliberately in order to avoid anyone else trying to sell

[3] The H&M Foundation is a non-profit organization, privately funded by the founder of H&M (H&M Foundation, 2017a). Its mission is to drive long lasting positive change and improve living conditions by investing in people, communities and innovative ideas (ibid).

[4] The Circle Textiles Program develops the tools data and projects needed to close the loop in the textile industry (Circle Economy, 2017a). The program is initiated by Circle-Economy which was launched in 2014 as a social enterprise with a mission to accelerate the transition to circularity (Circle Economy, 2017b).

them. I:Collect[5] (2017c) agrees that the fashion industry wastes valuable resources as well as it causes environmental harm. They state that worldwide each year, 150 million tons of clothing and shoes are sold whereby the majority is disposed of as landfill or is incinerated instead of being reused and recycled (I:Collect, 2017c). H&M Foundation and Accenture found in their report that 95 per cent of all the textiles thrown away today, could be re-worn or recycled (Olsson et al., 2017). Mistra Future Fashion[6] (2015) states that prolonging the lifetime of clothes can have substantial impact. They write that if clothes could be used 3 times longer, it would reduce the carbon footprint with 65 per cent and reduce the water use by 66 per cent.

I:Collect (2017b) argues that the key reasons for the large amount of wasted garments are '...low consumer awareness and urgency and a lack of collection structures in many countries.'. Deloitte (2012) predicts that the awareness among consumers will increase in the future. Their study finds that in 2020, consumers will care about price, convenience and quality when deciding where and what to shop as well as they will expect that businesses value environmental aspects to the highest extent possible. They describe that a sustainable business transformation, which considers sustainability as a core pillar in the business strategy is necessary for consumer companies, in order not to lose market share and competitiveness. The report further states that the transparency of the Internet means that companies are exposed and thus under pressure to answer to their customers' demand.

Textiles can in the end of their Lifecycle either get - reused, recycled into new products, used for energy, or become waste dumps, i.e. end up in landfill (Palm, 2011). In the end-of-life phase of the product, the factors that decide what will happen are; quality, condition and fashion accuracy (ibid). The optimal option environmentally wise is to reuse because reuse prevents waste, reduce emissions from the waste management as well as reduce new production (ibid). The abovementioned thus speaks for a circular fashion industry that focuses on reuse. H&M Foundation (2017c) writes that a circular fashion industry would enable the industry to eliminate waste, recirculate it and use the raw materials for new goods which would create value for both the environment as well as the Industry.

TU Delft (2017) proclaims that the fashion industry play an important role within circular economy and that the mind-set of this business is beginning to shift from linearity to circularity. They state that the potential for closing the loop for textiles is substantial since it will eliminate textile waste downstream as well as displace the virgin industry upstream. In order for the industry to go circular, the industry should produce and sell as much as they recycle and collect, or as another alternative, the industry has the potential to change the

[5] [5] I:Collect is a global solution's provider for collection, reuse and recycling of used clothes (I:Collect, 2017a). Today the company collects clothes in over 60 countries (ibid).

[6] The Mistra Future Fashion Research Program was initiated in 2011 by Mistra, the Swedish Foundation for Strategic Environmental Research, to address the sustainability challenges of the Swedish fashion industry (Mistra Future Fashion, 2015).

business models to be based on leasing instead of buying (TU Delft, 2017). Roos et al. (2017) also state that collaborative consumption models, for example to lease clothes for a monthly membership fee, is one approach for the fashion industry to transition towards a more circular economy. They further say that another approach is to slow down fashion consumption via creating high quality garments as well as focus on repairing and maintaining the clothes. A third alternative approach is to recycle and thus increase the reuse of garments (ibid).

However, H&M Foundation (2017c) depicts that producing new textiles out of discarded clothes is one of the biggest challenges the fashion and textile industry face today. They say that technologies for recycling textiles are evolving and today some technologies for recycling single fiber textiles exist but for mixed textiles there is still a lack of technologies. The Swedish Environmental Research Institute, found that the prime barrier for sustainable textile waste management in Sweden is economical (Palm, 2011). He means that today it is too cheap to produce new clothes in comparison with reusing old ones, since the Swedish fashion companies place their production in low cost countries and the collection for reuse in Sweden has much higher labor expenses. Today, the environmental costs are not included when calculating cost of production from virgin textiles, which results in lower cost for the production with new materials (Ibid).

Regarding the future prospects of circular economy within fashion, The H&M Foundation and Accenture conducted a study on the 2016 years' participants in H&M's competition for sustainable innovations within the fashion industry: The Global Change Award[7] (Olsson et al., 2017). Based on the entries in the competition, the study depicts five trends within circular economy and fashion; (1) there are hidden resources in nature from which it is possible to create new natural materials and substances that could have substantial positive sustainable effects, (2) leasing clothes will increase, resulting in decreased waste, (3) reusing old clothes will increase, resulting in decreased waste, (4) new innovative ways to recycle clothes will emerge, (5) clothes will be connected to the internet and the information gathered would enable the ability to better track the materials which in turn would decrease the risk of clothes that are thrown away before they are torn, as well as the transparency would enable an easier recycling process due to the increased traceability.

[7] The Global Change Award is a competition held by H&M Foundation, initiated in 2015 and collects entries involving innovations within fashion that will foster a more sustainable industry (H&M Foundation, 2017b). The competition is based on three areas: circular business models, circular materials and circular processes (ibid).

2.4. What Does The Circular Economy Mean for Business Processes?

The following section describes how the business processes need to change in order to enable a circular economy and will focus on the processes of design and reuse, thus the birth of the product and the end of life phase of the product. Lastly the chapter describes how sustainability and circularity can be measured in these processes.

2.4.1. Circular Design and Reverse Logistics

Lieder and Rashid (2015) mean that a successful move towards a circular economy implies a radical change in the way a business is run. They state that the transition changes both business perspectives, technological perspectives as well as policies. The Ellen MacArthur Foundation et al. (2015) elaborate on these changes and describe that the transition to a circular economy requires changing strategies, business models and systems which in turn requires changes within the firm and thus affected business functions, for example; logistics, offerings, services and manufacturing processes. They further state that the processes within a circular product Lifecycle are; design, manufacturing, distribution, use, recollecting (reverse logistics), and reuse/recycling/refurbishing. Figure 2.11 illustrates how a closed loop system could look like. The figure takes inspiration from how the Swedish clothing chain Lindex foresees their closed loop system to look like in their Sustainability Report (2016).

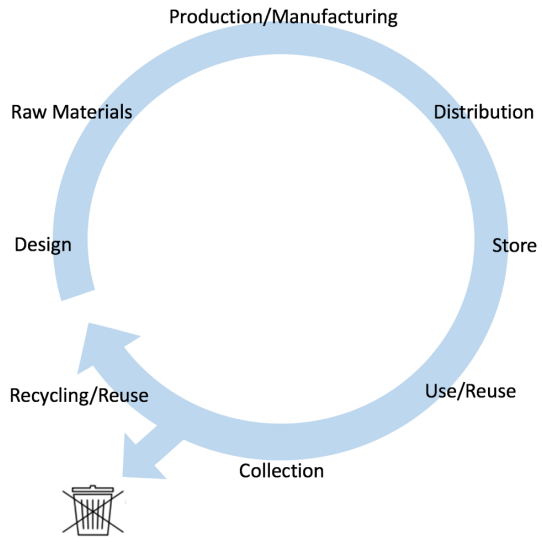

Figure 2.9. The figure visualizes one example of the closed loop of a circular fashion company based on the picture in Lindex's Sustainability Report (2016, 9).

In order to enable circular processes, the design of the product is crucial (Sarkis and Zhu, 2008; Ellen MacArthur Foundation, 2015a; Lieder & Rashid, 2015). Sarkis and Zhu (2008) state that in a circular economy scenario, the focus of the product Lifecycle should start at the

birth of the product, i.e. in the design phase. In that way, the waste can be designed out of the product from the very beginning. They mean that a circular economy aims to eliminate waste and the best way to handle the waste is prevention. Also The Ellen MacArthur Foundation (2015a) states that in a circular economy, waste is eliminated through designing the product in a different way, for example through long-lasting quality, using reusable materials, minimal number of components and focusing on modularity. The Ellen MacArthur Foundation (2015a) further states that the circular design is what facilitates the restoration and regeneration in the end-of-life phase, which is why they proclaim that circular economy '...is restorative and regenerative by design...' (Ellen MacArthur Foundation 2015a, 2).

Likewise, Lieder and Rashid (2015) argue that the circular design needs longer-lasting products, increased modularization as well as designs with less material. They mean that this way of designing enables for the product to be adapted to several Lifecycles and upgrading. Zhijun and Nailing (2007) agree that designing for circularity is crucial for a successful transition to a circular economy. They state that designing circular products require taking in consideration of the whole product Lifecycle, from the extraction of raw materials to disposing of the product, in order to minimize negative externalities within these processes. TU Delft (2017) also states that the remanufacturing process can be made more efficient if it is considered already in the product design since they mean that this will save both time and money in the remanufacturing process. Lieder and Rashid (2015) state that the processes of circular economy; reusing, upgrading and refurbishing do not only require another design in terms of the construction of the product but that it is also necessary to incorporate information in the product somehow. They stress that is important to incorporate the information in the product from the very beginning, so that it is later on available to those involved in the maintenance, remanufacturing and/or recycling phase. In this way, they mean that the different phases within the product Lifecycle can communicate, enabling efficiency in these processes.

As a conclusion from the abovementioned, the design phase is crucial in a circular scenario. However, The Ellen MacArthur Foundation et al. (2015) state that in order to enable the switch towards a circular economy, companies need to develop new core competencies within the circular design of the product, so that the processes of reusing, recycling and cascading can be enabled. They say that these needed skills, information and working methods are, in most cases, not available for companies today. Important to add though, is that in order to reach a circular economy and closed loop supply chains, not only the design is important to consider. It is also necessary to focus on the end-of-life phase of the Lifecycle and on the reverse logistics (Lieder and Rashid, 2015). The reverse logistics involve recollecting the products, reusing them, remanufacturing them, recycling them and reintroducing them on the market again (ibid). In figure 2.12, the reverse logistics of the fashion industry is illustrated based on I:Collect's recollection program (I:Collect, 2017b). The figure illustrates how the garments can be both reused into the same loop, (reuse), upcycled into new garments in the

same loop (closed loop recycling) or down cycled into other loops/industries (open loop recycling).

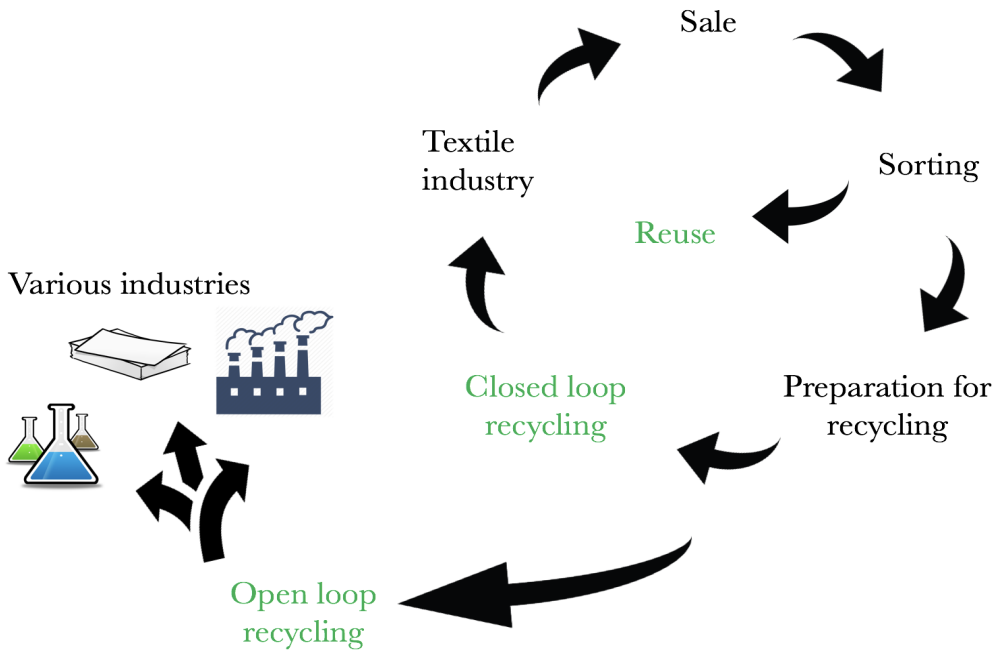

Figure 2.10. The figure shows how the reverse logistics of a circular fashion industry could look like based on I:Collect's (2017b) recollection processes.

Lieder and Rashid (2015) claim that in order to achieve efficient closed loop supply chains, economically viable value recovery activities are needed. They claim that an efficient closed loop supply chain requires methods that enables the business to handle the data related to the Lifecycle. According to The Ellen MacArthur Foundation (2015a) the leakage of materials out of the system will decrease if business develop; '...cost-efficient, better-quality collection, treatment systems and effective segmentation of end-of-life products…' (The Ellen MacArthur Foundation, 2015a, 16). TU Delft (2017) emphasizes that there is a current lack of scientific knowledge within the engineering and business aspects of remanufacturing in order to achieve an efficient closed loop supply chain. They also state that the recycling processes are difficult to perform because of the lack of information of what is inside the garment. Taking into consideration The Ellen MacArthur Foundation et al.'s (2015) statement above, that there is also a lack of skills and information in order to enable circular designs, imply obvious hinders towards changing these business processes. TU Delft (2017) highlights the research questions of how to organize reverse logistics and how to incorporate new technologies in the remanufacturing process, as highly important to seek answers to today.

2.4.3. Measuring Sustainability and Circularity

When moving towards a circular economy, measuring the progress is vital, both in order to determine which product is the eco-friendliest but also in order to provide measures of how to design for a circular product, internal performance, external reporting and investor analysis (Franconi et al., 2016). Today there are already metrics used within businesses in order to measure the environmental impact (ibid). Lifecycle Assessment (LCA) is one of several available tools for measuring sustainability in the textile industry (Roos et al., 2017). LCA is a method for assessing the potential environmental impacts from a company's materials, products, processes, or activities (United States Environmental Protection Agency, 2017). The assessment is based on the Lifecycles from Cradle-To-Grave (Arvanitoyannis, 2008). B Corporation (2008) explains that a LCA for a typical product takes into account the raw materials needed, the manufacturing process used, the packing of the product, transportation of both raw materials and the product, the use of the product and finally the disposal of the product. LCA covers a wide range of environmental impacts such as; global warming, ozone depletion, eutrophication, photochemical smog, toxicity, resource depletion, and land and water use (Franconi et al., 2016). Arvanitoyannis (2008) says that the information LCA provides can be used as support in decision-making for improving the company's environmental aspects. Roos et al. (2017) mean that LCA is a unique tool since it can provide industries with quantitative answers from all parts of the Lifecycle, considering a wide range of environmental issues. Franconi et al. (2016) argue that LCA is informative but that it also requires a lot of effort, it is complex, used mostly at product level, is still rare and still remains within professional circles.

Furthermore, measuring the carbon footprint is today a necessity for large businesses (ibid). World Resources Institute (WRI) together with World Business Council for Sustainable Development (WBCSD) developed a standardized approach for carbon metrics at company-level (Franconi et al., 2016). The main result from this cooperation is a global standard for measuring, managing and reporting greenhouse gas emissions called The Greenhouse Gas (GHG) Protocol that has been used since 2006 as a base for the International Organization for Standardization's ISO 14064-I standard (Greenhouse Gas Protocol, 2017). Peters et al. (2015) mean that analyzing the carbon footprint help industries improve the product Lifecycle since they can choose the most optimal alternative in terms of carbon emissions. In terms of measuring circularity, both LCA and GHG do that to some extent, but Franconi et al. (2016) argue that these metrics do not take in consideration of the re-flows of circular economy and the new material flows. Franconi et al. (2016) mean that when going circular it is necessary to measure, for example, how much of the products that are kept in use for a long time and how many products that goes to reuse or recycling. Franconi et al. (2016) make the distinction of a linear and circular product;

> ‘Any product that is manufactured only using virgin feedstock and ends up in landfill at the end of its use phase can be considered a fully ‘linear’ product. On the other hand, any product that contains no virgin feedstock and is completely collected for recycling or reuse at the end of its use phase can be considered a fully ‘circular’ product.’ (Franconi et al., 2016, 201).

Franconi et al. (2016) further proclaim that in a circular scenario, metrics should enable designers to choose the most sustainable option in the design stage and they should allow for both comparing products as well as for deciding minimum requirements for the products bought.

One sustainability measurement tool that is widely used in the clothing industry is The Higg Index, developed by The Sustainable Apparel Coalition (SAC) which is an alliance for sustainable production within apparel, footwear and home textile industry (Sustainable Apparel Coalition, 2017a). SAC has 160 members that together produce approximately 40 percent of the world's output of apparel, footwear and home textile and is today the largest apparel trade organization in the world (Patagonia, 2015). SAC’s vision is to lower the environmental harm from these industries (Sustainable Apparel Coalition, 2017a). SAC’s Higg Index is a standardized supply chain measurement tool that aims to understand the environmental, social and labor impacts of all industries (Sustainable Apparel Coalition, 2017a). The Higg Index is a self-assessment tool used to distinguish strengths and weaknesses in companies’ supply chains, identify areas of improvement as well as enable transparency (Sustainable Apparel Coalition, 2017a). When organizations use the Higg Index they attain a score of their level of sustainability performance of brand, product, material, or factory (H&M, 2016).

The Higg Index has different types of modules for measuring different aspects. The Higg Index Product Tools help designers and developers create products with a lower environmental impact (Sustainable Apparel Coalition, 2017c). The Higg Index Product Tools measure the product's environmental impact from all stages in the product-development cycle (initial prototype, choice of raw materials, design) (ibid). Tools available for this purpose are; The MSI Contributor (Material Data Submission), where the user submit data to be scored, The Higg MSI (Material Sustainability Index), where the user can compare materials and thereby make better decisions when choosing material, The Higg DDM (Design and Development Module), where designers and developers can gather knowledge of how they can create more sustainable garments (Sustainable Apparel Coalition, 2017b). The Higg Facility Module is divided into two sub-modules; the environmental and the social and labor module (Sustainable Apparel Coalition, 2017b). The environmental module measures the environmental management systems, energy use and greenhouse emissions, water use, water waste, emissions of air, waste management, and chemical use (ibid).

One metric that is commonly used by companies is a European Union regulation; REACH: The Registration, Authorization and Restriction of Chemicals (European Commission, 2016).

It was created with the aim to '...improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry.' (European Chemicals Agency, 2017). Before the regulation entered into force in 2007, EU had a legislative framework for chemical substances, but it did not include the effects that the chemicals had on human health and the environment (European Commission, 2016). Thus, the goal for creating REACH was to improve an early identification of properties of chemical substances (Sustainable Apparel Coalition, 2017d). In REACH, companies register relevant information and specific properties of the substances whereby REACH spread the information downstream (Sustainable Apparel Coalition, 2017b; European Commission, 2016). Substances with high concern have to get through an authorization before use (European Commission, 2016).

2.4. What Can Product Lifecycle Management Systems Do To Support Business Processes?

This section describes the definition of a Product Lifecycle Management (PLM) System and the very similar Product Data Management (PDM) System. Thereafter it discusses the concept of Closed Loop Product Lifecycle Management System followed by an introduction of how IT in general, and circular economy could create value together.

2.4.1. Product Lifecycle Management System

A Product Lifecycle Management (PLM) system is an IT system that manages the company's products within the product's Lifecycle (Stark, 2015). The system helps companies keep track of, and store information of, the products and thus control the products (Saaksvuori and Immonen, 2002; Stark, 2015). Stark (2015) argues that PLM is a digital paradigm where a company's products are managed with digital computers, digital information and digital communication. Berriche et al. (2016) claim that the most used definition of a PLM system is founded by CIMdata (2003), cited in Berriche et al's (2016) study:

> '…a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination and use of product definition information across the extended enterprise from concept to end of life - integrating people, processes, business system, and information.' (Berriche et al., 2016, 541).

PLM systems are used by companies in a wide set of industrial sectors such as manufacturing, process manufacturing, distribution and service industries, research, education, military and governmental organizations (Stark, 2015). PLM is supported by Information Communication Technology (ICT) which means that the product data is shared during different stages of the product Lifecycle (Terzi et al., 2010). Sharing the data allows for effective communication and means that all actors involved in the product Lifecycle can collaborate within the same

system (Berriche et al., 2016). Lieder and Rashid (2015) think that PLM could enable circular processes. They believe that ICT has the potential to enable the PLM system to incorporate products and parts in multiple Lifecycles.

Stark (2015) claims that a PLM system trains the user to see the whole Lifecycle of a product by which he means that for example in the design phase the user can also take in consideration of how the product will be manufactured, disassembled and recycled. He argues that the users of the system can communicate in order to create more efficient processes as well as create revenues across the Lifecycle. Stark (2015) further states that PLM is a tool that can increase product revenues and reduce product-related costs and risks, as well as it can result in time reduction and quality improvement. Saaksvuori and Immonen (2002) say that an efficient PLM ensures companies a competitive advantage. PDXpert (2017) argues that a PLM solution is extra useful when defining, controlling and sharing fast-changing products or complex, multi-discipline products. Saaksvuori and Immonen (2002) explain that PLM ensures a fast and easy distribution and reutilization of data related to the products and their activities.

The business processes in the PLM are unique for each business (Stark, 2015). Stark (2015) means that each company has to create their own business processes since the business processes define what people in the organization should do in order to achieve a business objective. Hence, a business process contain information of how the organization wants to either design, manufacture, support, use or recycle a product (ibid). Stark (2015) argues that this information, all the action around the processes as well as the many processes necessary, require organization.

2.4.1. Product Data Management System

Product Data Management (PDM) System is an IT system that manages the product's data (Stark, 2015). PDM is an application, or a part of PLM (Stark, 2015; Business Dictionary, 2017). PDM tracks the product data, i.e. the specifications of the product, manufacturing and development, types of materials within the product etc., in order to manage and make calculations (Business Dictionary, 2017). PDXpert (2017) claims that both PLM and PDM tools can be used by the same company and that there are sometimes overlaps. One significant difference between PDM and PLM is that PDM contains knowledge about Computer aided design (CAD) and PLM contains knowledge about the product definition and its relationships (PDXpert, 2017). Stark (2015) explains that there is a large volume of product data in the PLM system and that companies use PDM in order to keep this data under control. PDM supports activities in the PLM when designing and managing the design, when sharing data between multiple users, when tracking orders, and when controlling product configurations (Stark, 2015).

2.4.2. Closed Loop Product Lifecycle Management System

In a Closed Loop Product Lifecycle Management (Closed Loop PLM) system, the product Lifecycle is divided into three phases: beginning of life (BOL), middle of life (MOL), and end of life (EOL) (Jun et al., 2007). BOL includes design and production, MOL includes logistics, usage, service, and maintenance, and EOL includes reverse logistics, remanufacturing, reuse, recycle, and disposal (ibid), see figure 2.13 for an illustration of the information flows in a closed loop PLM system between these phases.

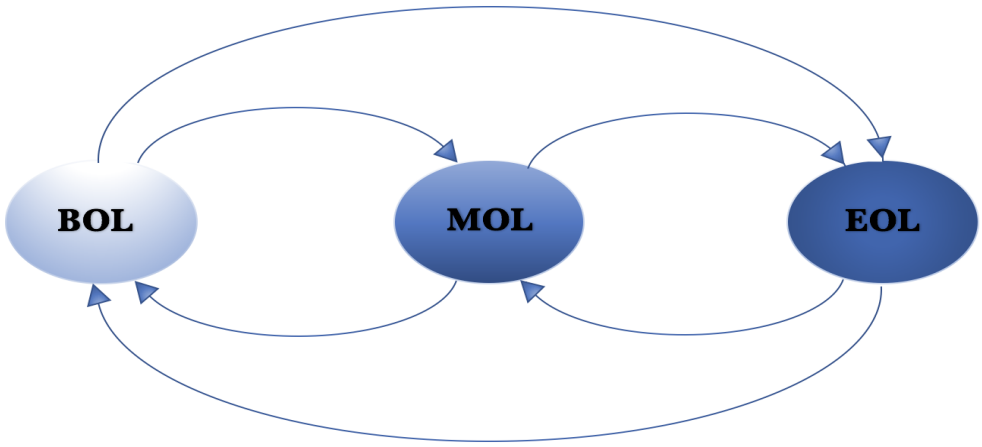

Figure 2.11. The figure illustrates the information flows in the closed loop PLM system based on the picture from Daaboul et al. (2016, 1066)

A main distinction between PLM and Closed Loop PLM is that PLM does not exploit information from MOL and EOL (Daaboul et al., 2016). Liljedahl[8] describes that the PLM system is mostly used within the product development phase whereas the concept of Closed Loop PLM system strives to include more parts of the Lifecycle. Jun et al. (2007) describe Closed Loop PLM as a PLM system that is more focused on transparency, allowing for all actors involved in the processes in the product Lifecycle to track, manage and control product information in real time within the separate phases in the Lifecycle. The benefits of the transparency and the access to real time information is, according to Jun et al. (2007), that Closed Loop PLM can facilitate the decision making in the processes related to the Lifecycle of the product. Daaboul et al. (2016) define the aim of the Closed Loop PLM as;

[8] Anna Liljedahl (Senior Advisor, TechniaTranscat) interviewed by the authors 5 May 2017.

> '…to allow information flow to go beyond the customer, to close the product Lifecycle information loops, to enable designers and manufacturers to get feedback of information from service, maintenance and recycling.' (Daaboul et al., 2006, 1066).

Daaboul et al. (2016) further state that Closed Loop PLM enables an integration, collaboration and direct exchange between phases in the product Lifecycle. Berriche et al. (2016) explain that the idea of this type of accessible platform is to enable information from one phase of the product's Lifecycle to be useful in another phase. Hence, Closed Loop PLM enables the designers and production engineers to attain information from the products' Lifecycles that they before did not have access to, which can be used as feedback that hence will improve the production and the recycling stage, as well as it can help the designers and production engineers to close the loop of the product Lifecycle (Jun et al., 2007; Berriche et al., 2016).

Storvik[9] says that the ideas of a Closed Loop PLM have existed for a long time but he believes that some aspects of the concept are still only a vision and do not work in reality. As an example, Storvik says that "Closed Loop PLM cannot allow for all actors involved in the product Lifecycle to track, manage and control product information in real time." as Jun et al. (2007) propose. Storvik means that the technologies are there but that the challenge is to collect and link the information efficiently so that the data can be used in different phases of the Lifecycle. He believes that it is necessary to have different kinds of IT systems in order to reach the vision of supporting the processes of the whole product Lifecycle. Only using PLM will not be sufficient according to him. He refers to other IT-systems such as; Enterprise Resource Planning (ERP) system for resources, planning and logistics, Supply Chain Management (SCM) system for supply chain and procurement, Manufacturing Execution System (MES) system for manufacturing execution and the operative production as well as Maintenance, Repair and Overhaul (MRO) system, as necessary. He further states that IOT (Internet of Things) is a supplement in order to connect all processes and tasks.

In a similar way, Stackpole (2016) means that different combinations of IT-systems offer different values, for example; (1) by integrating ERP with MES the company can sync the record for customers with order and inventory data, in order to meet the production requirements in a more optimal way and for reconciling material consumption for improved planning, (2) by integrating PLM with MES the company can improve and facilitate the feedback between product design and production. Storvik[10] states that even though one IT system is not enough in order to achieve a closed loop circular economy, he believes that PLM is essential since it contains the definition of the product. He describes that the company using Closed Loop PLM can choose which areas of the BOL, MOL, and EOL they want to focus on the most. One company that today uses Closed Loop PLM is Dassault (Griffiths,

[9] Johannes Storvik (CTO, TechniaTranscat) interviewed by the authors 7 May 2017.
[10] Johannes Storvik (CTO, TechniaTranscat) interviewed by the authors 7 May 2017.

2015). Key features of their Closed Loop PLM are; real-time traceability of supplier data enabling them to control the delivery-flows, real-time KPIs and analytics of warehouses, production and quality enabling them to detect quality risks and the root cause of defects (ibid).

2.5. IT and Circular Economy

Stuchtey et al. (2016) argue that the integration between technology, economy and environment is crucial to get right in order to reap the benefits of a circular economy. They inform that a new technology platform is necessary and mean that the technology revolution that is happening and will happen, is going to transform the value chains. They refer to the technologies of '[...] driver-less cars, precision agriculture, 3D printed houses, cheap clean energy, and the internet of things.' (Stuchtey et al., 2016, 31). The Ellen MacArthur Foundation et al. (2015) agree that technology and circular economy can create value together. In their study, they show that adopting principles within circular economy, integrated with the ongoing technology revolution, means that Europe can achieve a net benefit of €1.8 trillion by 2030 which is €0.9 trillion more than in the linear development path. Likewise, Sarkis and Zhu (2008) write that IT can enable managing the environmental burden caused by the industries and they believe that IT planning and management is critical from an environmental point of view regarding the analyses on individual, organizational, municipal, regional, national and global level. However, they emphasize that there is a need for further studies on how to develop and apply Lifecycle analysis and design for environment tools and integrating these with IT such as ERP systems, in both China and internationally.

The report: Intelligent Assets produced by The Ellen MacArthur Foundation (2016), emphasizes the potential for IOT and Circular Economy. They mean that the connectivity will enhance the value that can be derived from circular processes as well as facilitate these. One example that shows the value of IOT and big data within circular processes is described to be the process of reverse logistics. Today's problems with reverse logistics are fluctuating demand and supply for the second-hand market for the used products, as well as the varying conditions of the returned products (Ellen MacArthur Foundation, 2016). Thus, when companies are choosing the next use cycle for the returned product, lots of information is necessary and several factors need to be considered in order to decide whether to reuse, remanufacture, recycle or refurbish (ibid). Hence, there is a great need for a system that tracks the product, collects information of the condition of the product and the market situation, as well as an analytical model that uses the data, in order for the process of reverse logistics to work (ibid).

World Economic Forum et al. (2014) predict that raw materials' prices will rise while the cost for reverse logistics will decline because of technology progress such as advanced tracking systems and treatment technologies. They mean that this will spur the efficiency in both

forward- and reverse logistics. As an example, they explain that RFID[11] (Radio Frequency Identification) can be used to track the status, location and condition of the product, which will reduce the processing cost. RFID can also be used to define the formulation and composition of the materials, enabling efficient handling of the recollected products (World Economic Forum et al., 2014). This will thus spur the cascade of the materials so that each material can be reused in the most suitable and high-value application (ibid). The Ellen MacArthur Foundation (2016) further discusses the potential of every product becoming a digital entity presenting its material components and all its manufacturing processes and producers. Such a transparent supply chain is not only beneficial to the companies but also to the customers allowing for informed buying decisions (ibid).

To add, if technology allows for knowing the condition of the product, it also allows for proactive maintenance (Ellen MacArthur Foundation, 2016). If the system can signal when maintenance is needed, its lifespan can be prolonged (ibid). As a subsequent value of collecting all this information, the data gathered could be used in order to improve the quality of the product and product design (ibid). Also Persson et al. (2016) believe that IOT and circular economy will create value together. They write that digitization, Big data and IOT can be used within the reverse logistics to enable keeping track of flows and effective reallocation between demand and supply for different resources. They state that in order for the reverse logistics to work, sustainable and economically viable business models are necessary. Harris, head of Sustainable Business at Cisco EMEA, says in the report by World Economic Forum et al. (2014) that IOT will connect the materials, components and products digitally which results in that the materials can be reintroduced into new loops, while solving issues within transparency, ownership, quality and value. Further, the report shows that IOT can enable direct exchanges between two parties, without the involvement of institutions, which will facilitate the new flows within circular economy.

The abovementioned thus imply that IT is important, if not to say crucial for enabling a circular economy.

[11] RFID is a technique for storing data electronically in a chip and the stored data can be read and updated electronically (Identsys, 2017).

3. Methodology

Chapter 3 first introduces the strategy of the research where after the data collection is described followed by an explanation of how the interviews were conducted and a presentation of the respondents. Thereafter, it is described how the data was analyzed and how the research quality was upheld.

3.1. Research Strategy

The research strategy was based on multiple case studies, explained by Eisenhardt (1989) as focusing on investigating the dynamics of single settings. The collected information is of qualitative character, based on an inductive research strategy, meaning it relies on gathered data to generate theories and provide the basis for the analysis (Bryman, 2008). Furthermore, the inductive research contextualizes the data and provides in depth information from a fewer sample (Braun and Clarke, 2013). Since the purpose of the study is to understand a complex phenomenon, identify and understand the necessary changes and problems within the area as well as analyzing solutions to these changes within a PLM system, the data is of a complex structure in need of contextualizing.

The research question was formed as a basis for the case studies, which according to Eisenhardt (1989) is required in order to build theory from the case studies and collect the relevant data systematically. Stating the research question did not only enable a narrow focus for the gathered data but it also allowed for deciding who to interview as well as the scope of the research. Furthermore, the gathering of data for the theoretical framework was initiated in parallel with stating the research question, acting as a basis for comparing the findings of the interviews. In this way, when the findings from the case studies converged with the data based on theory, the empirical findings gained a firmer empirical grounding (Eisenhardt, 1989).

3.2. Data Collection

The data in the study was collected through a literature review based on database research, scientific articles, books and an academic course, as well as through data gathered from empirical research of multiple case studies based on two data collecting methods; interviews and archives. When basing the empirical research on two data collecting methods, triangulation, which allowed for validation of the constructs of the thesis, could be achieved (Eisenhardt, 1989). The interviewees were from two areas. Employees in charge of companies' sustainability as well as experts within the field of circular economy. The archives data collecting in this thesis meant gathering data from the companies' sustainability reports, webpages and other sources providing information of their work within sustainability, as well as gathering data from the experts' backgrounds relating to sustainability and/or circular economy.

3.2.1. Qualitative Interviews

The interviews were conducted in a qualitative manner. Bryman and Bell (2003) explain that qualitative interviews are more flexible than quantitative in the way that they can shift direction depending on the interviewed as well as it allows for following up interviewees' reply so that detailed information can be attained. The nature of this project's data requires collecting in-depth knowledge and information. The area of investigation is complex and requires a lot of input from the companies, as well as it requires follow-up questions and discussions in order not to misinterpret the answers, which in accordance with Bryman and Bell (2003) explain the choice of conducting qualitative interviews.

Bryman and Bell (2003) further distinguish two types of qualitative interviews: unstructured and semi-structured. They explain that unstructured interviews are not based on ready-made questions as is the case in the structured interviews, but instead allow for the interviewees to talk more freely. In the case of the research at hand, all interviews were prepared in advance with ready-made questions, thus structured. However, the interviews with the experts were based on the individual's background and experience and the interviews with companies had standardized pre-made questions slightly adapted to the specific company. The interviews with the experts did tend to become more unstructured since the aim was to learn about their area of expertise which oftentimes resulted in them talking more freely about the concept of circular economy rather than answering pre-made questions. In contrast, the interviews with the companies focused on finding out how they work in specific processes requiring pre-made questions, thus more structured.

Throughout the period of conducting the interviews, the questions were adjusted i.e. questions were added, withdrawn or changed based on the findings from previous interviews. This method is according to Eisenberdt (1989) a way to capture emergent themes that occurs during interviews. In theory building research, this strategy is valid since it is necessary to understand each case individually and on a deeper level, hence Eisenberdt (1989) means that the method offers the opportunity to better ground the theory. For those interviewees that wanted to get the questions beforehand these were sent in advance. The interviews were held one per company and one per expert except for the case of Emma Enebog. This respondent was interviewed both as an expert and as a representative of a company, due to her expertise within circular economy being Chairman of Cradlenet[12] as well as her employment as Head of Sustainability at Myrorna. At all interviews except the interview with MQ and with Company X, one person was interviewed. In the interview with MQ and with Company X, two persons were interviewed in each interview. The reason for interviewing two persons at Company X and MQ was because they themselves believed they then would be able to provide more comprehensive answers of the questions.

[12] Cradlenet is a network aiming to use and spread information about circular economy in Sweden and internationally (Cradlenet. 2017b).

All interviewed were given the choice to be anonymous. One of the interviewed companies chose anonymity. If the interviewee could not answer a question during the time of the interview, due to lack of knowledge in that specific area, the interviewee added answers after the interview via email. The interviews were audio-recorded where after transcribed. Due to the qualitative nature of the thesis, gathering the right information and thus having a correct record of the interview is important (Braun & Clarke, 2013). During the interviews, at all times possible, both authors were present, which according to Eisenbredt (1989) allowed for more creativity and complementary insights than if the interview was conducted with only one of the authors present. The different perceptions of the data allowed for noticing different findings. It also brought more substance when the same conclusions could be drawn from the findings, as Eisenbredt (1989) mentioned as one of the perks of being more than one interviewer present. Further, the interviews were all held in Swedish, except for the interviews with Lewis Perkins, President at C2C Product Innovation Institute, Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, Bert van Son, CEO of MUD Jeans and Marco Moro, Editor of Renewable Matter. These were held in English due to the non-Swedish origin of the interviewee. All other interviews have been translated to English.

3.2.2. Purposive Interview Sampling

The respondents were selected in a non-random way, through a purposive interview sampling. The purposive interview sampling is recommended by Bryman (2008) to be used in a qualitative research as it means that the interviewees will be chosen due to their relevance to the thesis' aim. The sampling was divided into two segments; experts in different areas concerning sustainability and circular economy in particular, see table 1, as well as interviews with consumer and retail companies, see table 2. The sampling of the experts was made based on their knowledge within and experience of circular economy and sustainability. In terms of describing the sampling of the companies, it is necessary to provide the definition of a consumer and retail company that is used in this report. The definition of a retail company is a company that sells products or services directly to a consumer and consumer industry means that the product is designed for the individual consumer rather than for a business, manufacturer or industry (BusinessDictionary, 2017b; BusinessDictionary 2017c). Lindfred[13] describes that a retailer is usually a company that buys their products and sometimes design from an external manufacturer before selling them to end users. Thus, the consumer and retail sector in this study is defined as involving companies that sell products or services directly to a consumer, made for the individual consumer's needs, with either internal or external manufacturing, or with a mix of both internal and external manufactured products.

Important to add is that one common denominator among the participating companies is that they to some extent are active within the textile industry. Seven of the interviewed companies fall within the clothing/fashion sector, out of which five companies are within fashion and

[13] Hannes Lindfred (Business Consultant, TechniaTranscat) interviewed by the authors 10 June 2017.

three are within outdoor clothing. Furthermore, there are two second hand retailers having all kinds of consumer goods products including clothes, as well as there are one within the furniture sector and one within the consumer goods sector, selling several different kinds of products including clothes. The reasons for choosing consumer and retail companies within textiles are twofold. The first reason is that this thesis is conducted on the initiative of the department of Consumer and Retail at TechniaTranscat. Hence, these companies are the potential buyers and users of the PLM system and thus relevant to the thesis' aim. This thus affected what companies were interviewed in the thesis to some extent. Some of the interviewed were suggested participants from TechniaTranscat and some of the interviewed were contacted by the initiative of the authors.

The second reason for why the consumer and retail sector, and in particular the textile sector, is relevant to investigate in this thesis is because of the urgency and potential of switching to a circular economy within this sector. Firstly, the manufacturing industry overall has one of the biggest potentials regarding economic and environmental impact (Ellen MacArthur Foundation, 2017b). Secondly, the consumer and retail industry in particular, is predicted to be under constantly increased pressure from the consumers to consider sustainability aspects within their operations (Deloitte, 2012). Specifically the fashion and textile sector generates a substantial environmental impact (I:collect, 2017c; Circle Economy, 2017a) but still bears the potential of moving towards a more circular economy; 95% of all textiles that are wasted today could be re-worn or recycled (Olsson et al., 2017). To add, circular economy is making inroads in the textile and fashion industry. This is seen in the increasing amount of companies that incorporate circular economy within their long-term strategies within this sector. The fashion company H&M and the furniture company IKEA, are examples in the forefront of incorporating circular economy in their business strategies (H&M, 2016; IKEA, 2015).

The interviewed companies are in different sizes, with different business models and have different degree of work within sustainability. Four companies have circular business models today. A differentiated set of participants was actively sought for, in order to provide a comprehensive view of the transition to a circular economy in regards to both opportunities and barriers as well as in order to provide an understanding of the transition in different settings and with different prerequisites. Therefore, the sampling of consumer and retail companies active in the textile industry, in different sizes, with different business models and with a varying degree of circularity, provided a group of companies under pressure of transitioning, in an industry where the shift is beginning to happen, while at the same time, all companies are users or potential users of a PLM system. These factors imply that the sampling is relevant to the thesis' aim. Important to add, is that the selection naturally also to some degree depended on the availability and will to participate among the potential interviewees.

On a side note, it is important to take in consideration that the interviewees from the companies were not from the IT function of the company, but rather involved in

sustainability. This was noticed in some cases, implying a lack of knowledge regarding their IT system. This affected the data gathered of how the IT system supported the business processes. In those cases, the respondents had insufficient information, the interviewees answered via e-mail afterwards, allowing them to find the answer in the company. One alternative method could have been to interview both a representative from the IT department as well as a representative from the sustainability area in order to get a more holistic perspective and also analyze the gap between the functions.

3.2.3. Respondents

In table 3.1 the experts interviewed are presented and in table 3.2, the interviewed employee/s and the company is presented. In Appendix p.1-4, more detailed descriptions of the experts' backgrounds are presented.

Table 3.1 The table presents the interviewed experts.

The interviewed experts		
No.	**Interviewed**	**Title**
1.	Bang, Erik	*Program Manager* at H&M Foundation
2.	Bergman, Marcus	*Senior Consultant and Sustainability Strategist* at IPM Ulricehamn
3.	Enebog, Emma	*Chairman* of Cradlenet
4.	Larsson, Jonas	*Associate Professor* at Borås University
5.	Linder, Mats	*Project Manager* at The Ellen MacArthur Foundation
6.	Moro, Marco	*Editorial Director* at Renewable Matter
7.	Perkins, Lewis	*President* of Cradle to Cradle Product Innovation Institute
8.	Wallenholm, Fredrik	*Associate Sustainability Analyst and Project Manager* at Allies

Table 3.2. The table presents the interviewed companies and the employee/s interviewed.

The interviewed companies			
No.	**Company**	**Concept**	**Interviewed**
1.	Company X	European retail and home electronics company that sells products from a wide range of suppliers	**i.** Mr.X, *Quality Strategist* **ii.** Mrs.X, *Sustainability Strategist*
2.	Fjällräven	Global outdoor retail company, both buys and manufactures their products.	**i.** Christiane Dolva, *Sustainability Manager*
3.	IKEA	Global retail and home product company, manufactures all their products.	**i.** Per Stoltz, *Sustainability Developer*
4.	KappAhl	Fashion retail chain in northern Europe, manufactures their own products.	**i.** Fredrika Klarén, *Sustainability Manager*
5.	Lindex	Global fashion retail chain, manufactures their own products.	**i.** Lena Törn, *Purchase Developer*
6.	Mud Jeans	Denim brand that leases jeans in Europe.	**i.** Bert Van Son, *CEO & Owner*
7.	Myrorna	Sweden's largest chain store for second hand products as well as Sweden's largest collector of used products.	**i.** Emma Enebog, *Head of Sustainability*
8.	MQ	Fashion retail chain in Sweden and Norway, both manufactures own products and buys external brands.	**i.** Helen Göthe, *CSR & Environment Responsible* **ii.** Eleonor Björserud, *CSR & Environment Responsible*
9.	Patagonia	Global outdoor retail company, manufactures their own products.	**i.** Mihela Hladin, *Environment & Social Initiatives Manager*
10.	Pure Waste	Creates clothes from 100% recycled materials, from textile leftovers from production.	**i.** Noora Alhainen, *Project Manager*
11.	Sellpy	Collects used products in Sweden and sell them online	**i.** Michael Arnör, *CEO & Founder*
12.	Stadium	Sport retail chain in Sweden, Finland and Germany. Both manufactures and buys external brands.	**i.** Catrine Marchall, *Sustainability Manager*

3.3. Analyzing The Data

When analyzing the data from the empirical findings, constant comparisons were used, described by Strauss and Corbin (2015) as analyzing and comparing data in regards to their similarities and differences. The process of constant comparison meant that the raw data from the empirical research was first broken down into segments that could be analyzed. Thereafter, through brainstorming, the possible meaning of the data, as well as similarities and differences in this data were analyzed. Similar data was grouped together, forming relevant concepts that was based on their recurrence throughout the interviews and their relevance to the research question. The concepts were thereafter differentiated between levels of concepts and categorized in accordance to their properties. Strauss and Corbin (2015) describe this part as categorizing the higher-level concepts and sub-categorizing the lower-level concepts, see figure 3.1. Finally, core categories were formed which describe the major structure of the study, see figure 3.1. (Strauss and Corbin, 2015). This way of analyzing is described by Strauss and Corbin to be a part of the so called Grounded Theory Analysis. This process allowed for pinpointing the themes/categories that the data indicated (Strauss & Corbin, 2015).

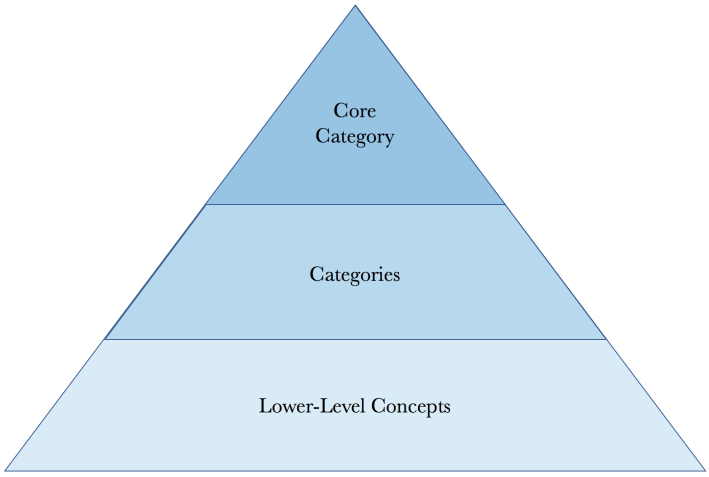

Figure 3.1. The figure represents the construction of a grounded theory, based on Strauss and Corbin (2015, 77).

Furthermore, theoretical comparisons were used, i.e. comparing the identified concepts with the theoretical framework, with the purpose of becoming more aware of what to search for in the data as well as to enlarge the theoretical sampling, in accordance with how Strauss and Corbin (2015) describe theoretical comparisons. Theoretical comparisons enable the researchers to discover variations and patterns and thus lifting the view of the case to a more abstract level (ibid).

3.4. Research Quality

In order to increase the credibility of the research, triangulation, peer reviewing and check-up meetings with supervisors at TechniaTranscat and Chalmers were performed in accordance with Shenton's (2004) recommended measures to increase credibility. Furthermore, the interviews with the experts worked as a complement to the theoretical framework and ensured the reliability and accurateness of the data collected from books, articles and documents as well as they added a firmer grounding to the findings of the interviews with the companies in those cases when the conclusions derived from the interviews with the companies, converged with what the experts stated (Eisenhardt 1989). The interview scripts and questions were formulated together with the supervisors and experts as well as revised during the project to ensure that the correct information was attained. The interviewees were offered anonymity, so that the respondents were comfortable telling the truth even in the cases of sensitive data. Moreover, the empirical findings, presented in the thesis were sent to the interviewed for confirmation in order to ensure that the information was rightly interpreted.

Since the empirical research was conducted through two data collecting methods, the triangulation lowered the risk of a biased research and thus increased the confirmability (Shenton, 2004). Even though these precautions were made in this research, Shenton (2004) emphasizes that it is almost impossible to eliminate bias in a qualitative research. In terms of bias from the employer of the thesis, this was lowered since the supervisors were never present in the interviews. However, the supervisors helped analyzing some of the findings foremost in terms of the applicability to the PLM system as well as they were involved in forming the questions for the interviews. Although, the authors were also free to interpret and analyze without any direction or involvement from the company. Considering the fact that the empirical findings were discussed with the supervisors at TechniaTranscat in order to get insight and feedback on the possible solutions and tools that could be used, the findings could be scrutinized and analyzed from more perspectives than only the authors, allowing for a more holistic view of the problems. On another topic, the transferability of the study is enhanced by the explanations made in the thesis of how the research was conducted and what demarcations and boundaries the study is based upon, which is stated in the end of the thesis.

4. The Empirical Research

The empirical research presents the findings from the twelve interviewed companies as well as the eight interviewed experts. In addition, it also presents the data collected from archives. The interviews with the companies discuss how the companies currently work within their processes related to the product Lifecycle, how they would like to work in order to become more sustainable, how their IT systems support these processes today, as well as what tools, aids and information that they miss in order to enable more circular processes. The interviews with the experts discuss the concept of circular economy, their view and experience of the circular model as well as their ideas of how to enable the transition.

The chapter is organized as follows. First, it introduces the interviewees perceptions of the current transitions to a circular economy, followed by the current status of circular economy in the interviewed companies. This is presented in order to provide a background of the status of circular economy today according to the interviewed. This section is followed by a short presentation of the interviewees view of the complexity of the transition. Thereafter, the empirical findings of how the companies work within the processes related to the product Lifecycle are presented, together with the interviewed experts' knowledge in the matter. The most critical processes within the product Lifecycle when moving to a circular economy according to the interviewed, are here presented. It was found that the design and the end-of-life phase are the most important phases to transform in order to enable a circular economy, therefore, these two phases, the problems as well as possible enablers to these problems, brought up by the interviewees, are presented in separate sections.

The first part of the empirical research thus presents the data used to answer the research question, narrowing it down to the respondents' suggestions of tools that could enable more circular business processes within the product Lifecycle i.e. the transition in the range of the PLM or IT system. The final section 4.5. however, presents another view of the transition not only considering the processes related to the product Lifecycle. The reason for this outline is because the findings clearly show that several other enabling conditions are needed in order to make the transition. The findings indicate the necessity to consider other factors than those directly related to the processes in the product Lifecycle.

4.1. The Transition to a Circular Economy

Several of the interviewees agree that changing the linear economic model into a circular one, both in the fashion industry as well as in other industries, is a stressing issue. Emma Enebog, Chairman of Cradlenet and Head of Sustainability at Myrorna, states that "The circular economy exposes the linear model's idiocy.". She means that circular economy allows for companies to understand how ineffective the linear model is. She describes it as "The concept of circular economy allows for companies to understand the language, the model and the business opportunities a more sustainable economy bears with.". Marcus Bergman, Senior

Consultant and Sustainability Strategist at IPM Ulricehamn, also explains the "…stupidity…" of the current linear model, and in terms of the fashion industry he says that; "The current business model is leaking products and is simply put, too ineffective.". Erik Bang, Program Manager at the H&M Foundation, exclaims that "Things need to change, it is no other choice for the industry and neither for the planet.". Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, agrees with Erik Bang. She believes that "It is not an option for companies today to do nothing.". She says that it is the businesses that are the real drivers of change whereby she means that all businesses have to take their responsibility, "Now more than ever.".

Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, believes that "There is a logical shift in the industries, all necessary factors are aligned and the prerequisites exist for a circular economy to emerge.". Associate Professor Jonas Larsson writes in the report Re:think - towards positive impact that;

> '...right now there is a golden opportunity to use the apparel and textile value chains to create a positive impact. Much of the manufacturing technology is there, the management systems are well thought-out and waiting to be implemented, materials for circular economies are being manufactured on a large scale and the customers are waiting.' (Persson et al., 2016, 56).

In addition, Jonas Larsson emphasizes in his interview that there are currently several initiatives among companies creating prerequisites for a circular economy, such as preparations for product´s infrastructure and experiments with different ways of giving the clothes a new life. He states that "Circular economy within fashion is happening.", a statement aligned with Noora Alhainen's, Project Manager at Pure Waste, who says that "Recent years have shown a change within the fashion industry and circular economy will happen.". She believes it is thanks to social media and internet that the information gets wide spread fast, which is why she says "It will not take long until the masses are concentrating on what they are wearing and where the garments are made.". Also Marco Moro, Editor at the Magazine Renewable Matter, has noticed the increasing interest towards circular economy, not only in fashion. He says that "The transition towards a circular economy in Italy is visible in the increasing sharing economies and the many grassroots initiatives.". He also adds that there has been an increased interest towards their magazine both in Italy and in general. Mats Linder, Project Manager at The Ellen MacArthur Foundation, is also positive towards the future in terms of the transition to a circular economy and says that "Today it is difficult to have a strategy that does not involve circular economy somehow.".

4.1.1. The Status of Circular Economy

Below, the participating companies' work within circular economy is presented.

Company X

Both the Quality Strategist as well as the Sustainability Strategist at Company X, say that Company X has not incorporated circular economy in their strategy and they state that currently they have no plans of doing so. They however recollect used products with the aim of reusing and recycling instead of combustion (Company X, 2017a).

Fjällräven

Fjällräven's goals are to create products for durability, use the most environmental processes in production they can find, use as much ecological materials as possible, lower their use of energy in production, try to avoid dangerous chemicals and try to reuse waste materials (Fjällräven, 2017). In Fenix Outdoor (2015) it can be read that Fjällräven tries to repair, re-use and recycle to the widest extent possible. Christiane Dolva, Sustainability Manager at Fjällräven, believes that circular economy is gaining traction at Fjällräven and explains that they have started to investigate different ways of leasing their products as a first step. She also describes that they are currently investigating how they can use their cutting spill for up-cycling and that Fjällräven is cooperating with different actors for achieving this but she confesses that they have not yet come up with a viable way of reusing the production spill. Fjällräven has also launched Eco-Shell which is a fabric made from recyclable polyester (Fenix Outdoor, 2015). Fjällräven is a member of Sweden Textile Water Initiative[14] and the Textile Exchange[15] (Sweden Textile Water Initiative, 2017b; Textile Exchange, 2017a).

H&M Foundation

Erik Bang, Program Manager at H&M Foundation, explains that their competition, The Global Change Award, has grown rapidly since the start in 2015 and that they get entries from many different parts of the world. Today, the Global Change Award is one of the world's largest competitions for early stage innovation (H&M Foundation, 2017b). The background for creating the competition is quoted from the H&M Foundation's webpage;

[14] The Sweden Textile Water Initiative was founded in 2010 by a few leading textile companies together with Stockholm International Water Institute with the aim of creating a platform for knowledge sharing about how water consumption in the textile industry could be reduced (Sweden Textile Water Initiative, 2017a). The initiative creates guidelines for a more sustainable textile industry (ibid).

[15] Textile Exchange is a non-profit working towards reducing the impact of the textile industry through improving farming, materials, processing, traceability and end of life (Textile Exchange, 2017b). They have members from over 25 countries (ibid).

> ‘If the fashion industry could be circular instead of linear, it could efficiently eliminate waste and re-circulate raw materials and valuable resources to produce new goods. But to make the fashion industry circular and help protect our planet, the industry needs game changing ideas.’ (H&M Foundation, 2017b).

Erik Bang says that their entries pinpoint certain processes or specific business models, whereby he says that “No single solution will make the world circular, but if brought together, several solutions would create a circular system.”.

IKEA

IKEA is part of Circular Economy 100 (CE100) which is a global platform that encourages companies to become more circular, initiated by The Ellen MacArthur Foundation (IKEA, 2015). From this collaboration, IKEA has developed the “Circular IKEA” concept including the areas of Prolonging Product Life, Designing for Circularity, and Resource Chain (i.e. to use more secondary materials) (ibid). IKEA also started a project of collecting unwanted IKEA furniture from customers which they resell or donate (IKEA, 2015). Per Stoltz, Sustainability Developer at IKEA, describes IKEA’s work within circular economy as focused on three core pillars; “…meeting the customer, designing product and building the value chain.”. Further, IKEA aims to eliminate waste from their own production as well as to motivate their customers to turn waste into resources through offering containers and different storage solutions for food and for recycling (IKEA, 2015). One of IKEA’s internal goals is to recycle 90 per cent of their own waste. Today 78 per cent is recycled and 11 per cent is recovered (ibid). IKEA is also part of Better Cotton Initiative (BCI)[16] and is a member of The Sweden Textile Water Initiative (IKEA, 2017; Sweden Textile Water Initiative, 2017b).

KappAhl

According to their sustainability report (2016), KappAhl strives to become circular and their goal is to reuse or recycle all of their materials (KappAhl, 2016). They want to increase the reuse, upcycling and create a comprehensive system of collecting used clothes (ibid). In order to achieve this goal, they have divided their sustainability work into five parts of the value chain: design, production, logistic, selling, and consumption. In order to foster customers to donate their old clothes they hand out vouchers for every donated bag (KappAhl, 2016). KappAhl started to collect garments in 2015 and during the following year they collected 128 tons of clothes and textiles out of which 60 per cent was resold and the rest remade into new materials (KappAhl, 2016). KappAhl is a member of the Swedish Trade Federation’s network

[16] BCI (Better Cotton Initiative) is a standard for providing sustainable cotton production covering environmental, social and economic factors, non-profit (BCI, 2017). The Better Cotton Standard System makes up of 6 components, for example involving monitoring and evaluation, providing a global definition of better cotton, supporting and training etc. (ibid).

Textiles for Recycling Initiative[17], as well as a member of the Mistra Future Fashion Program with the purpose to become more circular (KappAhl, 2016). Further, KappAhl is a part of Better Cotton Initiative and The Sweden Textile Water Initiative (KappAhl, 2017; Sweden Textile Water Initiative, 2017b).

Lindex

Lindex writes in their sustainability report (2015) that they aim to close the material loop to a greater extent than today, by increasing the use of sustainable, reused and recycled fibers and materials. Lindex has started to reuse and recycle their products, collecting used clothes in 50 of their stores in cooperation with Myrorna (ibid). During 2015, Lindex collected 3.5 tons of textiles for reuse or recycling and in the same year, 2 per cent of their products was made from recycled pre-consumer fibers (ibid). In spring 2016, their first up-cycling product was released, made out of post-consumer denim fabric, and in 2017 Re:Design was launched, a collection of upcycled garments remade from their last season denim products (Lindex Group, 2016). 80 per cent of their clothes should be made of sustainable materials and 100 per cent of their cotton shall come from organic, recycled or Better Cotton in 2020 (Lindex Group, 2015). In 2015, 47 per cent of Lindex's products was made out of more sustainable fibers such as organic cotton, Better Cotton and recycled fibers (ibid). Lindex is also a part of Mistra Future Fashion Program, Textiles for Recycling Initiative, The Sweden Textile Water initiative and Textile Exchange (Mistra Future Fashion, 2017b; Swedish Trade, 2015; Sweden Textile Water Initiative, 2017b; Textile Exchange 2017a).

MUD Jeans

MUD Jeans has a circular business model. According to the CEO Bert Van Son, they create "…as sustainable jeans as possible.". MUD Jeans leases their jeans to their customers and the returned jeans are upcycled into a vintage pair (B Corporation, 2017). Their core value is sustainability, where they question the impact fast fashion has on the environment and tries to find alternative ways of selling clothes (MUD Jeans, 2017a). MUD Jeans' goals are to eliminate the use of chemicals, close their circuit for 100 percent recycling as well as produce the first carbon neutral pair of jeans (MUD Jeans, 2017b). In their denim process, they cut worn out jeans into pieces, blend them with virgin cotton and create new denim yarn (ibid). They use BCI Standard and GOTS[18] Certified Cotton and they use printed labels on the jeans instead of leather labels in order to minimize using different types of materials and thus design for recycling (MUD Jeans, 2017a).

[17] The Textiles for Recycling Initiative was formed by members of Svensk Handel (Swedish Trade) in order to create better conditions for reuse and recycling of textiles (Swedish Trade, 2015). Today the initiative contains of eleven companies who together make up more than half of the Swedish market for clothes and home textiles (ibid).

[18] GOTS (Global Organic Textile Standard) is a globally spread textile processing standard for organic fibres, including ecological and social criteria (GOTS, 2017). GOTS defines requirements for organic status of the textiles, from raw material to labelling, using one globally accepted certification (ibid).

Myrorna

Myrorna has a circular business model, collecting and selling used clothes (Myrorna, 2017). After collecting the materials, it is being sorted at production units; 7 per cent goes to energy recovery, 73 per cent is exported to either be reused, recycled or combusted and 20 per cent is sent to their stores for sales (Myrorna, 2017). In Myrorna's Sustainability Report from 2015, their 2 main goals are described; (1) increase the reuse, (2) circular adaptation. In order to move towards more circularity, Myrorna will increase the collection of products through increasing the availability for customers to return used products as well as increasing and improving the communication towards customers (ibid). Furthermore, the report says that Myrorna will increase the tracking of the products and develop full traceability from the point of collecting to the point of sales, with the goal of reaching more transparency and improve managing the value chain. In Myrorna's case this means managing towards maximized reuse and minimized combustion/landfill (Myrorna, 2015). Myrorna is also part of Mistra Future Fashion Program (Mistra Future Fashion, 2017b).

MQ

Helen Göthe, CSR and Environment Responsible and Eleonor Björserud, CSR and Environment Responsible, at MQ say that they themselves are well aware of circular economy but explain that circular economy is not something that is actively incorporated in MQ's current strategy. Although, they both describe that MQ's focus on selling high quality clothes with a long lifetime, goes hand in hand with the hierarchy of waste and thus hand in hand with circular economy. They believe that MQ will achieve the largest environmental gains if they focus on longer lifetime of their products. Quality and clothes with a long lifetime also permeates MQ's sustainability report 2014/2015 (MQ, 2015). Their annual report of 2016 also emphasizes that MQ will focus on reuse and recycling. To add, MQ has a goal of reaching 100 per cent sustainable cotton in the year of 2020 and is part of Better Cotton initiative (MQ, 2016). MQ is also a member of the Textiles for Recycling Initiative, The Sweden Textile Water Initiative and Textile Exchange (Swedish Trade, 2015; Sweden Textile Water Initiative, 2017b; MQ, 2015; Textile Exchange, 2017a).

Patagonia

Patagonia has a circular business model where they manufacture, repair and recycle with the goal to extend the lifetime of their products (Business of Fashion, 2017). Patagonia provides a lifetime guarantee on their products (ibid). They repair the garments for as long as possible where after they recycle the products and give their customers a voucher corresponding to the value of it (ibid). Patagonia incorporates sustainability in all decisions and they have an extensive amount of sustainable materials (organic cotton, hemp, 100 per cent recycled down) and several sustainable processes (Patagonia, 2017a). In addition, Patagonia has an upcycling project where customers can turn in their worn-out Patagonia products (Patagonia, 2015). The products that can still be used are donated to a non-profit organization, if they are too torn the

materials are either remanufactured to their Fix Broken Clothing Department or are sent to their up-cycling partners (ibid). Another up-cycling project that Patagonia started is called Worn Wear, in which they set up events across the US where consumers can either turn in broken clothes for repair or pick up a garment at the event and repair it themselves (Patagonia, 2017b). Patagonia initiated together with Walmart, the Sustainable Apparel Coalition (SAC), which also developed the sustainability index The Higg Index, and now has over 200 members within the fashion industry (Sustainable Apparel Coalition, 2017e). Patagonia is also a member of Textile Exchange (Textile Exchange, 2017a).

Pure Waste

Pure Waste has a circular business model where they use waste materials and recycle them into new products (Pure Waste Textiles, 2017a). The created fabrics are made from 100 per cent recycled materials (Slush, 2017). Pure Waste's vision is to industrialize upcycled textiles globally (Pure Waste Textiles, 2017b). Pure Waste's core philosophy is that sustainability and quality goes hand in hand and that fashion and ecological thinking should too (Pure Waste Textiles, 2017b). Noora Alhainen, Project Manager at Pure Waste, says that their products have to be 100 per cent recycled and that "Pure waste's big goal is to make it normal in the industry to use recycled products.".

Sellpy

Sellpy's business idea goes hand in hand with circular economy. They increase the utilization of products through facilitating the process of selling used clothes for consumers (Sellpy, 2017). Sellpy offers the service of picking up the clothes from the customers, taking pictures of the products where after they also upload them on Tradera (Swedish version of Ebay) for online sale, providing all necessary information to the advertisement (Sellpy, 2017). Michael Arnör, Co-Founder at Sellpy, explains that the products are packed in environmental plastic, which are then transported by bike. He states that everything that is not sellable is given to Myrorna or Humana[19]. If the products have defects, they are recycled but this constitutes of less than 1 per cent of their collected products, according to Michael Arnör.

Stadium

Catrine Marchall, Sustainability Manager at Stadium, explains that the buying department at Stadium is aware of, and pushes the work within, sustainability and circular economy. Stadium has collected and donated used clothes since 2003 in collaboration with Human Bridge[20] (Stadium, 2017). In 2011, Stadium started the Re:activate Initiative, a non-profit charity initiative, aiming to give old clothes a new life (Stadium, 2015). In Stadium's

[19] Humana is privately owned, idea driven company active within individual- and family care, personal assistance and elderly care. (Humana 2017a; Humana 2017b)

[20] Human Bridge was created in 2001 and is today a foundation that collects, repairs and sends medicine, disability equipment and textiles to aid other countries (Human Bridge, 2017).

sustainability report 2015-2016, one of their environmental goals for their work until 2020 is described, 'All the cast-off and waste collected through Re:Activate becoming a part of our new raw material source in production' (Stadium, 2016, 23). Catrine Marchall states that the goal is also to be able to create new products out of the old ones and she says that they currently conduct tests with recycled cotton in order to see how they can up-cycle the collected clothes. Catrine Marchall says that Stadium also focuses on sustainable design and how to design to easier recycle. Stadium is a member of The Sweden Textile Water Initiative as well as Better Cotton Initiative (Stadium, 2016).

4.1.2. A Complex Transition

As evident from the above findings, several of the interviewed have started to incorporate circular economy within their businesses. However, the interviews also collide in that the transition is complex. The interviewees touch upon several barriers towards the transition to a circular economy. It is understood that there are more obstacles necessary to overcome in order for a successful transition than just those related to the business processes of the product Lifecycle. As an example, Mihela Hladin, Environment and Social Initiatives Manager at Patagonia says that

> "Circular economy offers a nice, simple framework for everyone to understand how things would need to work but there is a lack of a broader understanding of circular economy as well as a lack of technology in order for it to really gain traction.".

Hladin believes that the hardest part is knowing what to do. She says; "You don't get a handbook of how to do it circular or completely sustainable from A-Z.".
Furthermore, Associate Professor Jonas Larsson states that "…even though the prerequisites are there, there are still components missing in the value chain in order for the circular economy to really take off in the fashion industry.". He does not think the knowledge is there yet, neither the necessary infrastructure. Similarly, Per Stoltz, Head of Sustainability at IKEA, says "The move should not be underestimated.", and Catrine Marchall, Sustainability Manager at Stadium, highlights the complexity of circular economy when she says that "Today Stadium does not know how to get the circularity to work in the most effective way.". Still, she emphasizes that "The circular way is the right way to go.". Moreover, Mats Linder, Project Manager at the Ellen MacArthur Foundation, agrees that the move is complex. He means it is necessary to facilitate and enable the transition of a circular economy arguing that "The market currently has a knowledge and know-how deficit, but it will take a while for that to build up and to understand how to transition to more circular businesses in practice.".

4.1.3. The Product Lifecycle and IT

The interviewees are specifically asked about the processes related to the product Lifecycle and how their IT systems support these processes. To conclude, several of the interviewees

agree that IT and technology is necessary in the move towards circularity as well as they agree that it is necessary to adapt the system to the changed business processes within the product Lifecycle. Lewis Perkins, President of Cradle to Cradle Product Innovation Institute, states that "Technology investments are necessary in the shift towards circularity.". Bert Van Son, CEO at MUD Jeans, emphasizes the need for a customized IT system due to their circular business model. Regarding the PLM system, Lena Törn, Purchase Developer at Lindex, specifically says that "The ability to incorporate tools that can facilitate our work within sustainability, is one of the aspects we value in our new PLM system.". Helen Göthe and Eleonor Björserud, both CSR and Environment Responsible at MQ, state that "Our current PLM system is not optimal in terms of how it supports the decision making in our green processes.". In a similar manner, Fredrika Klarén, KappAhl's Sustainability Manager, states that the types of tools that could facilitate the decisions based on sustainability, do not exist in their PLM system today. She adds that she would like to see such tools at PDM or PLM suppliers.

In terms of the changed business processes within the product Lifecycle, the interviewees denote that the most stressing issue is the lack of reliable sustainability information in order to improve decisions based on sustainability, relating to the transparency of the business. It can be derived that this issue is most obvious in the design phase and in the end of life phase of the product. To exemplify, in Lindex' sustainability report (2015) it can be read that one of their biggest issues today is the traceability of their materials. Lena Törn, Purchase Developer at Lindex, explains that "Lindex needs improved transparency and traceability in order to have control and answer to the demand of their customers.". Associate Professor Jonas Larsson also emphasizes the need for transparency in the clothing industry when he says that "…it is important that everyone will know what the business processes look like.". He says that the fashion companies in general need to be better at mapping the environmental impact of their manufacturing processes in terms of water usage, energy use and waste management. Moreover, Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, illustrates the problem with the lack of information within the clothing industry by comparing it with the food industry, "We do not know anything about where the clothes we wear come from, whereas we know a lot of what the food contains. Still the production process is pretty much the same.". He means that the food industry is one step ahead the clothing industry in terms of transparency and that tracking information back to raw material has not been the focus of the clothing industry historically. He says that "The big sustainability issue in the textile industry is that the raw material industry is completely anonymized and changing this is a big industrial transformation.".

4.2. The Product Lifecycle - Design Phase

It is clear from the interviews that the design phase, see figure 4.1, is important to consider in terms of sustainability and circular economy. The findings below first present how the

interviewees currently work within the design phase in consideration to sustainability and circular economy where after the interviewees discuss what tools, aids and information that they miss, in order to make better decisions based on sustainability in this phase.

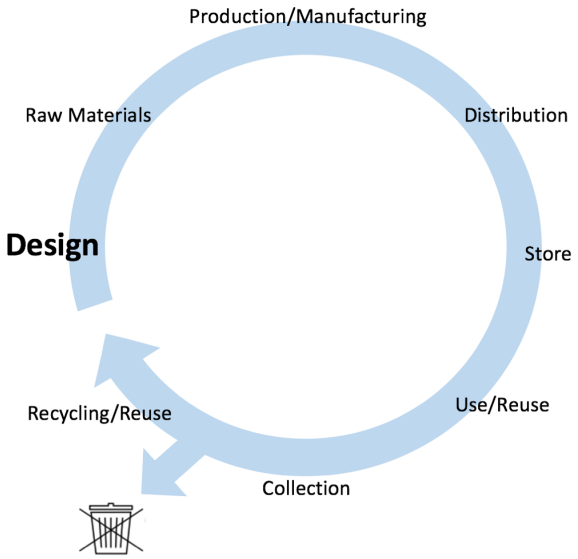

Figure 4.1. The figure is a copy of figure 2.11, illustrating how a closed loop circular business could look like, based on Lindex's Sustainability Report (2016, 9). The process of design is highlighted as it will be the topic of this section.

Fjällräven's Sustainability Manager Christiane Dolva states that "It is in the design phase, when choosing what materials to use, that Fjällräven allocates most efforts in terms of sustainability.". Fredrika Klarén, Sustainability Manager at KappAhl, explains that also they put the most emphasis on sustainability in the design phase i.e. "…in the choice of process and in the production of raw materials.". She expresses that it is in the manufacturing of textiles and clothes that they have the most risks and impact. Also Helen Göthe, CSR and Environment Responsible at MQ, agrees and says that the most effort is allocated to the design phase and "…the quality of the material, construction and shape.". Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, says that it is "…from the very beginning." they focus the most on sustainability.

Per Stoltz, Sustainability Developer at IKEA states that in the design phase "…IKEA needs to rethink the process and move from design-to-recycle towards design-to-circularity.". Per explains that IKEA uses tools in the design phase, that are developed from an eco-design point of view, which goes in line with the circular thinking. Per Stoltz means that it is required that the developers take in consideration of the circular processes. Also Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, says that in his project of investigating how furniture companies can transition to circular business models he investigated ways of designing for reuse. He draws upon one example where they changed the design of a company's chair to incorporating a zipper around the upholstery instead of gluing

it to the chair which allowed for taking off the upholstery without the need of sending it back to the factory.

Bert Van Son, CEO of MUD Jeans, states that they focus the most on the design to remanufacture in their product Lifecycle, in terms of sustainability. He describes that they try to design to remanufacture, through decreasing the use of different types of materials in each product. He means that it is a lot easier to recycle from only one raw material, making it easier to take apart the used products. Also Catrine Marchall, Sustainability Manager at Stadium, says that her department currently focuses on how to design to make it easier to recycle their products. She describes that they try to make the designers aware of not adding extra prints and/or having many different combinations of materials within one product. KappAhl focuses on sustainability through offering the design and purchasing department education in sustainable design (KappAhl, 2016).

In order to ensure what type of material that is used in their products, several of the companies conduct tests in the design phase, and all follow REACH[21] in order to phase out dangerous chemicals. To exemplify, KappAhl performs around 1000 random sample tests on finished products each year (KappAhl, 2016). Eleonor Björserud and Helen Göthe, both CSR and Environment Responsible at MQ, describe that the process of ensuring the quality of the material is different depending on the product. They explain that certified materials require documentation and takes the example of BCI standard, "Better Cotton ensures the material through Cotton Tracer which means documentation of where the material is from.". Furthermore, Mihela Hladin, Patagonia's Environment and Social Initiatives Manager, explains that Patagonia has several different types of certifications, allowing for transparency and tracking of the material and its processes. Bert Van Son, CEO of MUD Jeans, explains that in order to track their material they use certified cotton, and as for the recycled parts, he says that they visit the factories themselves to conduct audits.

When designing the product, not only the material is important to consider but also how it is produced and the supplier producing it. Several of the interviewed companies do internal and external audits to ensure that their suppliers produce sustainable products under fair conditions. As an example, Stadium chooses suppliers through a screening process, based on audits, where they check if the suppliers are able to manufacture products in consideration to the environment and human rights (Stadium, 2015). Another example is Company X who has developed a Code Of Conduct with the purpose to set standards and requirement towards their suppliers, and their sub suppliers on; environment, human rights, and ethical and responsible behavior within all fields of businesses (Company X, 2014). It is however clear during the interview with the Quality Strategist and with the Sustainability Strategist, from Company X, that in terms of environmental aspects, it differs from product to product. The two strategists

[21] REACH is a European Union regulation for registration, evaluation, authorization and limitation of chemical substances. The regulation aims to improve human health and the environment. REACH also demands the user of chemicals to gather enough information and uphold certain standards. (ECHA, 2017)

explain that there are no structured and specific guidelines concerning sustainability for the buying department. They state that in order to become more circular that has to change for Company X.

IKEA states that in order to make sure from where and how the raw materials are produced they have formed close cooperation with their suppliers and partners (IKEA, 2015). Pure Waste also focuses on a close cooperation with their suppliers. Noora Alhainen, Project Manager at Pure Waste, explains that the small size of Pure Waste allows them to have a closer cooperation with their partners. She says that they visit their partner in India that runs the daily processes, every third month. She continues and explains that since they use leftover industrial material from places that they know, thus they know the information of the material, i.e. how thick the yarn is, what fabric it is and what fibers that have been used. MQ also supports their suppliers work by ensuring they improve their production and lower their usage of water, energy, and chemicals (MQ, 2015). In a similar way, Lena Törn, Purchase Developer at Lindex, describes that Lindex work closely with suppliers to create incentives for them to switch to more sustainable processes and also educate them on how to make changes, if needed. One such initiative was the Better Denim Process, where Lena Törn describes that "One big step in our sustainability work was to consolidate the amount of suppliers and work closely with them.".

Christiane Dolva, Sustainability Manager at Fjällräven, describes that their Material Technician nominates specific products, specific materials and specific suppliers after collecting the requirements from the designers. Christiane Dolva explains that Fjällräven has had communication for several years with their nominated suppliers regarding Fjällräven's requirements within quality and environmental aspects. In this process Fjällräven follows their chemical restriction list and other specifications such as requirements for recycled content and for traceability. Christiane Dolva explains that Fjällräven, in this phase, communicate directly with the material suppliers, not only the manufacturers of their garments.

4.2.1. Barrier: Lack of Reliable Sustainability Information

It is understood during the case studies, that the audits, tests and evaluations described above is not enough in order to collect all necessary sustainability information about products, suppliers and processes. Fredrika Klarén, Sustainability Manager at KappAhl, states that they need to know the environmental impact of different materials and processes in order to know what choices to make in the design phase. She however explains that they do not have the data and the benchmarking to do this. Catrine Marchall, Sustainability Manager at Stadium, says that today they do not have the right tools to measure the impact and the emissions of the products. She adds that they currently investigate how a PLM or PDM system could facilitate this. She says that "The hardest part is finding the right tools for this.". MQ's two employees responsible for CSR and Environment, Helen Göthe and Eleonor Björserud, specifically

emphasize the need for information in MQ's design phase. They say that they currently put time and effort into investigating how they can collect the right information in order for more informed decisions as early as possible within the design phase.

Furthermore, both the Quality Strategist and the Sustainability Strategist at Company X acknowledge their lack of information in the design phase when they state that they need to get better at tracking the sustainability of their materials and processes. In addition, regarding Lindex' work with traceability of their materials, Lena Törn, Purchase Developer at Lindex, says that "Due to the complexity in the supply chain there are few tools supporting this data. One way is to work with sustainable fibers who have some certifications which makes it more transparent.". Lewis Perkins, President of Cradle to Cradle Product Innovation Institute, states that in a circular economy, the companies need to be able to base decisions on data in order to know what material to choose in the design phase. He believes that the processes that are in the strongest need of changing within consumer/retail are those around design and selection of materials. He further says that "…companies need the system-side of it in these processes…", by which he means they need to implement practices and design tools with the use of technology.

4.2.2. Enabler: The Higg Index

Some of the companies have started to use or are planning to use tools for gathering reliable sustainability information. The Higg Index, developed by The Sustainable Apparel Coalition (SAC), is one such tool. Based on the interviewed companies, the ones already using The Higg Index are Pure Waste, Patagonia and Fjällräven. Christiane Dolva, Sustainability Manager at Fjällräven, says that Fjällräven uses The Higg Index as well as other studies on material information in order to measure their environmental footprint. According to their sustainability report (2015), Fjällräven applies The Higg Index in order to facilitate the development of their reuse, and reclaim of materials as well as to choose the right materials (Fenix Outdoor, 2015; Fjällräven, 2017). Christiane Dolva adds that they use the Preferred Material List by The Higg Index where they rate the materials based on the available information. She says that Fjällräven are currently working on creating their own Preferred Material List which is made up by a combination of the Material Sustainability Index from Higg and other material benchmarks.

The companies interviewed that do not use The Higg Index today but want to incorporate it are Stadium, MQ and Lindex. Stadium wants to incorporate The Higg index because of "…the importance of having measurements when moving towards a more sustainable and circular economy.". Helen Göthe and Eleonor Björserud, both CSR and Environment Responsible at MQ, explain that MQ knows what processes have the biggest environmental impact in the manufacturing phase, however they lack the knowledge of the impact of specific products. Eleonor Björserud explains that she is currently investigating the processes of manufacturing and tries to find a way for MQ to choose the most sustainable processes. She

has used Made By's[22] tool for garment treatment, which is a process-map mostly concentrated to denim, where it is possible to see the amount of water and the risk for hazardous chemicals. She also says that she is "…looking into The Higg Index.".

Lena Törn, Purchase Developer at Lindex, also explains that they are investigating to join SAC and start using The Higg index when it is available. She says that "Lindex needs to be able to measure the processes and their environmental impact somehow.". Lena Törn mentions that they have already started to conduct Lifecycle Analyses on some of their products, "…in order to attain information and understand the parts of the process that has the most environmental impact.". Likewise, Catrine Marchall, Sustainability Manager at Stadium, talks about the importance of measurements and adds that The Higg Index is not something they work with today "…but might incorporate in the future.".

Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, describes that they use several different certifications but she believes that only using The Higg Index is the better choice since a streamlined tool allows for a streamlined communication to their consumers. She means that different types of measurements and certifications only make the consumers confused and thus does not enhance the traceability. Christiane Dolva, Sustainability Manager at Fjällräven, share Mihela Hladin's opinion. Christiane Dolva states that The Higg Index "…allows for a streamlined way of measuring and comparing products, both from the companies' perspective and the consumers perspective.". She means that for the consumer, if every product has the same labelling it is easier to compare and understand the impact, compared with today's many different standards and certifications. She believes The Higg Index to be the best alternative today since it incorporates a holistic collection of different sources of information and she hopes that Fjällräven will be able to add their own materials so that they can create a standardized way of approaching their suppliers. Christiane Dolva further thinks that a streamlined tool will be beneficial for the whole fashion industry and she believes The Higg Index will be a widespread tool in the fashion industry in the future.

In contrast, Associate Professor Jonas Larsson states that he thinks there will be several different tools similar to The Higg index that will also be based on Lifecycle analyses and that are adjusted to different types of businesses. Lewis Perkins, President of C2C Product Innovation Institute, also talks about the many different similar assessments that exists today and says that "…these assessments need to start to communicate with each other.". Lewis Perkins believes that the most effective way of measuring and providing reliable information is to have systems that speak to each other. He sees this lack of communication as a hinder towards the transition to a circular economy today. Moreover, during the interviews, some criticism towards The Higg Index is signaled. Fredrika Klarén, Sustainability Manager at KappAhl, highlights that "…creating a tool that is generically applicable is difficult.". She

[22] Made By is a non-profit consultant organization working towards improving the environment and social issues within the fashion industry. (Made By, 2017)

rather believes that it is necessary to; "…have your own process based on your own values, but complementing this process with other tools.". Although she believes that The Higg Index could be "…a harmonic and valuable tool for the whole fashion industry.".

4.2.2.1. IT and Higg

Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, describes in his interview that The Higg Index is a complicated system that requires a lot of resources and knowledge. Thus, he states that he thinks it is necessary to integrate The Higg Index into the company's IT system. He says that "The fashion companies do not possess the type of knowledge necessary to incorporate The Higg Index by themselves.". He however emphasizes the importance to "…not just build another layer of sustainability system on top of the enterprise system.". Endorsing the previous statement, Associate Professor Jonas Larsson believes The Higg Index to be a suitable tool to facilitate the decisions in the design phase by providing reliable sustainability information and explicitly says that it is a tool that could be incorporated in an IT system.

Lena Törn, Purchase Developer at Lindex, argues that "Lindex needs to have some sort of material database to incorporate more materials and their environmental impact." but she states that "…Lindex needs a better IT system in order to incorporate such a material database.". She explains that they currently use a limited, old PDM system and adds that they investigate the possibilities of using a PLM system. She says that Lindex value tools that can facilitate their work within sustainability in a PLM system but she however emphasizes the challenges of incorporating a tool such as The Higg Index. She means that the tool is complicated and in need of a lot of input data, as well as she sees it as necessary to link the PLM with other systems such as the system the designers use for sketches and 2D design, Adobe Illustrator.

Catrine Marchall, Sustainability Manager at Stadium, acknowledges that they need systems aligned with The Higg Index in order to use it, due to its complexity. Furthermore, Catrine Marchall states that Stadium does not use an IT system today in the way they would like. She adds that they would like to have a tool in the PLM system that measures how much of the assortment that is sustainable. She explains that today "If we would track materials, it is still necessary to manually track and then feed the information to the system.". As an example, she says that "If I would like to know how much cotton we use today, I would need to manually input the articles that contains cotton.". She adds that "We are currently investigating how a PLM system could help automate processes and be connected to the procurement processes as well as the order system.".

When Sustainability Manager at Fjällräven, Cristiane Dolva, is asked how their PLM system supports the processes within their product Lifecycles she states that they have incorporated a tool that grades the materials based on The Higg Material Sustainability Index, but that it is adapted especially to Fjällräven. She further adds that "Fjällräven would like to have a direct

link to The Higg Index, SAC and The Material Sustainability Index, MSI, within the PLM system". Christiane Dolva believes it to be unnecessary hard work to build the products in two systems, both the PLM and The Higg-Design Development Module. In the case of MQ, they do not use The Higg Index today but Helen Göthe, CSR and Environment Responsible at MQ, explains that they are working on improving their IT system so that it supports the sustainable processes more. She describes that they are currently upgrading their IT system so that it will incorporate a function for analyzing the risk of chemicals in the products as well as a function for adding the required quality-tests they want to perform on a product. Moreover, both Helen Göthe and Eleonor Björserud agree that today they have too many systems that they need to handle in order to get the holistic view of the processes.

4.2.3. Enabler: Scorecards

Besides using or wanting to use The Higg Index to improve the basis for making decisions, several of the companies interviewed use individually developed scorecards, adapted to their specific business. The importance of scoring different factors when moving towards a circular economy is highlighted by Per Stoltz, Sustainability Developer at IKEA and Mihela Hladin, Environment and Social Initiatives Manager at Patagonia. Per Stoltz believes that it is important that the focus on circular economy does not impede other factors. He says that "IKEA's customers do not value circularity as a factor…" whereby he says that "IKEA has to satisfy their customer needs in a circular way without compromising other aspects of the products.". Also Mihela Hladin from Patagonia talks about the importance of valuing all factors to the same extent. She means that it is important to not fail in other areas due to having too much focus on sustainability.

Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, describes the importance of having scorecards adapted to the specific business in order for the scoring to be valuable. From his experience working as Head of Sustainability at Gina Tricot, he noticed that the scorecard used did not facilitate the decision making in the design phase since the statistical information derived from the tool was difficult to base decisions on and not intuitive. He therefore developed a new one, through expanding the range of the index as well as he added additional scoring for other aspects. He tried to adapt the scorecard to incorporate metrics of other parts of the Lifecycle than only the design phase, enabling scoring factors that are important in a circular economy. He incorporated a similar scoring for the choice of transport and choice of supplier. He says that "…all sustainability-data of the transportation and of the supplier could be derived and levelled together with the information and scoring of the material into an automatically generated scoring of the total sustainability of the entire decision.". This was called The Good Index. However, Marcus Bergman describes that they tried to incorporate one more index into The Good Index which he explained as "…the statistics of how well the product sells when it hits the store.". When including this measurement, Marcus Bergman means that "…you avoid producing excess products and waste.". He explains that this would add to the sustainability index of the

product and guide the decision maker in whether it is sustainable to produce more products of the same or not.

Also IKEA has internally developed a scorecard for measuring products' impact and considering curricular aspects. It can be read in IKEA's sustainability report (2015) that IKEA uses something they call Democratic Design when designing products that they label as more sustainable products. The core of their Democratic Design is to create products that have the right combination of form, function, quality, sustainability and a low price (IKEA, 2015). A tool IKEA uses to measure the sustainability aspects of the Democratic Design is a sustainability scorecard (ibid). This scorecard includes and measures 11 criteria; getting more from less, use renewable materials, use reused and recycled materials, use materials from more sustainable sources, the recyclability of products end-of-life, the quality of products, the energy used in production, the renewable energy used in production, the raw-material utilization in production, transportation efficiency, and the sustainability of the products at home, i.e. products that enables customers to use less water, energy, reduce waste or a healthier lifestyle. The score goes from 0 to 400, where 400 is considered impossible to reach due to the complexity to score all 11 criteria for each and every product (ibid). Each product that scores over 120 are considered as more sustainable (ibid).

This tool enables IKEA to consider sustainability aspects in each stage of their product Lifecycle, according to their sustainability report of 2015. IKEA aims to increase their level of more sustainable products and to continue develop their scorecard tool (IKEA, 2015). In fall 2015, 54 per cent of their sales came from more sustainable products and the average score of their products were 109 (ibid). One way IKEA measures their impact is by tracking the sales of their products that they have categorized as more sustainable products (IKEA, 2015). Although, recently IKEA developed a new scorecard with 9 criteria focused to design, material and supply with more circular thinking, according to their Sustainability Developer, Per Stoltz. Per Stoltz explains that the criteria for scoring was developed at the design department collaborating with different stakeholders. Also Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, explains that they use a simplified scorecard for every product that scores the aspects of functionality aesthetics, social, environmental and price of the product. She states that on a scale from 1 to 10, the score needs to be an 8 for every single product and every single category. Mihela Hladin explains that, in this way, "…Patagonia does not compromise on functionality and quality for environmental gains.". She adds that they use the same type of scorecard in the supply chain.

Helen Göthe, CSR and Environment Responsible at MQ, says that they already score their suppliers from different parameters when deciding which supplier to choose. This scorecard includes environmental aspects and quality aspects. It is explained during the interview that MQ today works on integrating environmental aspects with the buying department so that they can make conscious choices environmentally wise. The production function and buying department discusses the suppliers and their scoring. Further, Lena Törn, Purchase Developer

at Lindex, explains that they use a supplier scorecard which is based on different criteria; "…waste, water, chemicals, social, sustainability and transparency…". She explains that in terms of water it is divided into water-waste and water use and that the suppliers with the highest score in this area are those that purifies the water and reuses their waste-water. In Lindex Sustainability Report (2015) it can be read that 80 per cent of their supply chain (40 suppliers) shall be ranked a 4 out of a 5 scale on their supplier scorecard grade in the year of 2020. According to Fjällräven's Sustainability Manager Christiane Dolva, Fjällräven scores the sustainability of the materials through measuring the functionality, quality and environmental footprint of the material.

Fredrika Klarén, Sustainability Manager at KappAhl, describes that KappAhl also uses a scorecard in order to be able to know the environmental impact of different materials and processes, however it only scores two factors. It scores whether digital printing is used and if a better production process of denim is used. Fredrika Klarén says that they look at these two factors because they have the data and insinuates that there is a lack of data to score other factors. She explains that "There are several databases for judging different environmental impact in Lifecycle analyses but there is still not a lot of information of what types of textile-processes and materials that you can use in the design phase.". Fredrika Klarén further explains that KappAhl is currently investigating a tool that scores their products on eight areas connected to sustainability. The eight areas concern the sustainability of the material, the sustainability of the processes, the manufacturing and the circular design. Likewise, MQ is developing a tool that aims to support the designers and purchasers in making conscious decisions with the background of increasing the amount of sustainable materials (MQ, 2016). The tool will be based on environmental aspects, Lifecycle analysis, traceability and quality (ibid). Eleonor Björserud, CSR and Environmental responsible at MQ, explains that the tool could be used to score the material on its sustainability, quality and traceability. She also describes that this tool was developed in order to make it easier for those involved to understand what high quality materials are and when one material or composition of material is better than another.

4.3.2.1. IT and Scorecards

Helen Göthe, CSR and Environment responsible at MQ says that currently, MQ's PLM system does not incorporate the scoring of the suppliers nor their tool for ensuring the quality of the material but if the PLM system could incorporate that information, it would enable them to directly steer the procurements towards the more sustainable supplier. According to Fredrika Klarén, Sustainability Manager at KappAhl, KappAhl aims to incorporate the scorecard in their PLM system, she states that "…it is a big step in KappAhl's work towards a more circular and sustainable business.". Fredrika Klarén also adds that these types of tools do not exist today and that she would "…gladly see similar tools at a PDM/PLM supplier.". She means that the scorecard they have developed today is too simple. She says that KappAhl

wants to work with databases and she emphasizes the need of having information of different sustainable processes as well as their quantitative impact.

Further, the Quality Strategist and the Sustainability Strategist at Company X also see the potential of incorporating data from their supplier scorecards, and also data such as carbon emissions per product and data from audits into their IT system. Likewise, Per Stoltz, Sustainability Manager at IKEA states that they saw the need for using an IT system for scoring when they noticed that the previous scoring, which was conducted through checklists, "…made it hard to achieve an actual result.". They acknowledged that they needed a tool that could "…measure the whole product range constantly and that would create one index per product.". Mihela Hladin, Environment and Social Initiatives Manager at Patagonia mentions that the process of scoring is done manually at Patagonia "…where all departments sit together and discuss the product line based on the scorecard.". She adds that "…they do not have the state of the art technology today.".

4.3. The Product Lifecycle - End-of-life phase

All interviewed companies discuss reverse logistics and recycling/reuse, see figure 4.2., representing this phase. They either talk about their existing reverse logistics or their future plans of incorporating it. Nevertheless, it is evident that all interviewed are aware of reverse logistics and how one could close the loop for the business. Associate Professor Jonas Larsson pinpointed the end-of-life phase as especially important to incorporate measures within and gather information of, in order for a successful transition towards a circular economy. He claimed that, it is necessary in order to take in consideration a holistic view of the sustainability of a product in a circular scenario.

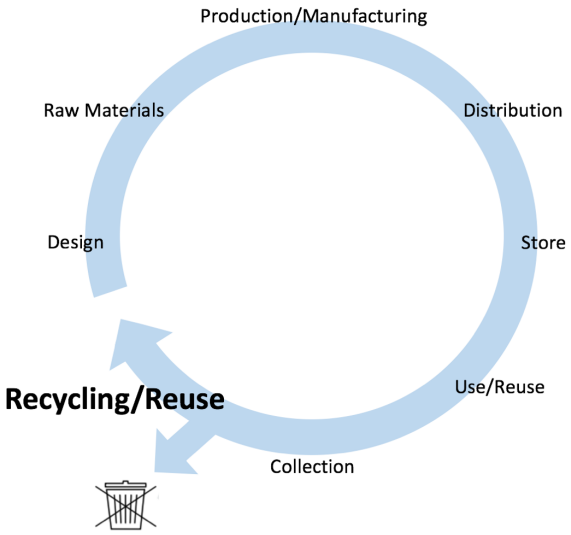

Figure 4.2. The figure is a copy of figure 2.11, , illustrating how a closed loop circular business could look like, based on Lindex's Sustainability Report (2016, 9). The process of reuse and recycle is highlighted as it will be the topic of this section.

Sellpy's and Myrorna's business models are based on reverse logistics since they sell second hand. MUD Jeans' business model also incorporates reverse logistics since they lease their products. Patagonia is also experienced in the field since they have had reverse logistics in their business model for a long time, offering a lifetime guarantee of their products and encouraging their customers to return, repair and donate their used clothes (Patagonia, 2015). IKEA, Stadium, KappAhl and Lindex have started to incorporate reverse logistics in their business by offering their customers to return used products (IKEA, 2015; Stadium, 2015; KappAhl, 2016; Lindex, 2015). Company X also incorporate reverse logistics to some extent. They offer their customers to return broken products, electronics and electronic equipment if they buy a similar new one at their store (Company X, 2017b). After collecting, company X evaluates whether to repair, reuse or recycle (ibid). The Quality Strategist and the Sustainability Strategist at Company X explain that they use the information from the collected products in order to improve their quality in the design phase, whereby they go back to the supplier and ask them to change their process if the quality is not satisfying. Lastly, Noora Alhainen, Project Manager at Pure Waste, explains that Pure Waste is a newly funded company and that their products have not yet been on the market for long whereby they have not yet incorporated reverse logistics. One common thread among the interviewees regarding the topic of reverse logistics is that they have encountered problems or foresee problems with the reverse logistics.

4.3.1. Barrier: Lack of Information

Emma Enebog, Chairman of Cradlenet and Head of Sustainability at Myrorna which has a business model with a focus on reverse logistics, describes that it is difficult to know how to sort the material and the chemical components of the material after its initial use, "…since they do not know exactly what the material consists of.". She adds that, knowing how to sort and then knowing how to recycle it, even if the clothes come from different countries, different time periods and different brands, is important in order to go circular. Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, also emphasizes the importance of knowing how to handle the products in reverse logistics. He says that

> "The process of taking back the products is one of the main obstacles for companies within consumer and retail going circular since today, the companies do not know when to reuse and when to recycle and the traceability of the components of the materials is an issue.".

He exemplifies the importance of knowing how to handle the products by saying that "Previously produced clothes which do not follow REACH might contain hazardous materials.". He also says that it is important to take into account and gather information of

how the products have been used and what they have been exposed to in order to know how to handle the material. He states that "…this data is impossible to track today.".

The issue with a lack of information in the end-of-life phase is furthermore illuminated by Lena Törn, Purchase Developer at Lindex, who states that a problem with scaling up their up-cycling initiative was the inability to know what the post-consumer material contained in terms of coloring and chemicals. Also Noora Alhainen, Project Manager at Pure Waste, states that their aim is to use post-consumer material for up-cycling but she also states that "Today we do not know how to control what is inside the material and thus we do not know how to up-cycle it.". She believes that in order to use post-consumer waste, they need to figure out how to perform the sorting of the products and the material. She says that this process is more complex than using pre-consumer waste since they need to test what material is in the product. Noora Alhainen explains that Pure Waste is currently part of projects investigating up-cycling post-consumer waste.

Likewise, Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, acknowledged from his study within the furniture industry, that "…knowing exactly how the product is produced and what type of materials it is made of is necessary, in order to know how a specific piece of furniture can be taken apart.". Fredrik describes how traceability and labelling is important in all industries in terms of reverse logistics. Also Lewis Perkins, President of C2C Product Innovation Institute, insinuates that when taking back the product after end-of-life it is necessary to know the information of the product in order to know how to handle the product. He states it is important to "…know how to separate them, how to sort them and how to collect them.".

Another problem with the reverse logistics noticed from the interviews is that the technique for recycling mixed textiles is undeveloped and expensive. In Fenix Outdoor (2015) it can be read that Fjällräven tries to repair, re-use and recycle to the widest extent possible. Christiane Dolva, Fjällräven's Sustainability Manager describes this work as challenging, especially in the recycling area. She believes recycling is the biggest obstacle in the fashion industry today towards becoming more sustainable. She thinks that "…there are many ideas for recycling but no commercially viable solutions.". When she is asked if the problem is a lack of information of the materials and the components in the product, or if it is the recycling techniques that are missing, she says that it is hard to say. She means that if the techniques are there, the information is necessary to have and vice versa. She describes that "Even though the material information is there, it is necessary to have data of the methods that have been used, the material blend, the coating, the finish and the dye.", which she means is information that needs to be provided of a chemical supplier.

Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, states that there are no well-developed techniques for reusing/recycling today and Catrine Marchall from Stadium agrees that "The technique for how to turn waste into resource for textiles is still not well developed for bigger production.". She says that Stadium currently investigates

how they should collect also the torn clothes, that people do not think is wearable, for recycling. They have joined a project together with University of Borås, Human Bridge and Swerea IVF[23], among others, in order to share knowledge of how to take care of the products after end of use. Currently, they conduct tests with recycled cotton in order to see how they can up-cycle the collected clothes but Catrine Marchall says that "…the result is not satisfying since the recycled material does not hold the same texture as the new material.". Noora Alhainen, Project Manager at Pure Waste, further explains that "…there is not enough knowledge and not the right machinery in the Nordic for recycling…".

4.3.2. Enabler: Tracking Materials and Products With IT

Catrine Marchall, Sustainability Manager at Stadium, states that "It is difficult to know whether or not the used product should be, reused, recycled, given to Human Bridge or maybe sold second hand.". She pinpoints that "Stadium would need some sort of measurement in this situation, as well as they would need to measure how much of the garments are recycled versus reused.". She emphasizes the need to integrate everything within the PLM or a tracer system, stating "…it is the only way.". Mats Linder, Project Manager at The Ellen MacArthur Foundation, emphasizes in his interview the complexity of reverse logistics compared to the traditional logistics from factory to customer since "…in reverse logistics you need to take back products from many different sources.". He explains that IT is crucial in order to get the re-flows to work. He means that reverse logistics can be facilitated through the use of digital tags allowing for tacking products via an IT system. He adds that "This system could potentially also track the status of the products, identify how torn the products are and thus also decide the current value of the product and how much the customer should get for returning it.". In these processes, Mats Linder sees IT as a huge enabler.

Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, also emphasizes the importance of IT in reverse logistics and says that an IT system such as PLM could help keep track of where the product is at all times, something he believes would be especially important in the furniture industry since there is no data of how much furniture is wasted today. He proposes using a tracker inside the furniture. Likewise, Lewis Perkins, President of C2C Products Innovation Institute, proposes that an IT driven tag, or "…a material passport…" could be assigned to the products and thus "…allow for tracking and tracing on a molecule level." (the formulation of the materials). He says that "…apart from knowing the current state of the product this would also allow for getting information of the history of the product as well as where the product should be sent next.". In this way Lewis Perkins means that the second life purchaser of the materials could be identified more efficiently, and that "…technology could tell us the value in the end-of-life phase of a product…".

[23] Swerea IVF develops and implement new techniques and processes focusing on product- , process-, and product development (Swerea IVF, 2017).

Also Lena Törn, Purchase Developer at Lindex, ponders over the possibility to incorporate a chip in the clothes in order to provide information. She believes that having a chip in the clothes could enable them to scale up their up-cycling initiative. In a similar way, Emma Enebog, Chairman of Cradlenet and Head of Sustainability at Myrorna, sees the potential of using an IT system in their reverse logistics. She describes how a "…blipping system…" would help their truck drivers automating the manual process of writing the inventory on a piece of paper where after they have to input the information digitally. She explains that "A system that could measure and track the inventory would be valuable, more time efficient and could enable a better tracking of their products.".

Michael Arnör, CEO and Co-founder of Sellpy, describes that their work mostly consists of logistics and keeping track of orders and materials. Michael Arnör says that they have developed an IT system themselves and he describes it as a small PLM system that keeps track of the orders and products. He says that "We have id-numbers on the bags, linked to the seller, for tracking, allowing the buyer and seller to see the current status of the product.". Michael Arnör says that when selling the product, they give as much information as possible of the condition, brand, quality etcetera but today, finding information of the collected products is a manual searching process. Michael Arnör believes that a more standardized process would be more efficient. He debates how a tag on each product would facilitate the process and allow them to "…scan and gather all the information of the collected product directly from the manufacturer.". He says that they currently investigate the possibilities of constant image-recognition. However, Michael Arnör confesses that "A standardized process for gathering information is complex to solve for Sellpy due to their many different types of products.".

4.4. IT Systems and Circular Economy

Associate Professor Jonas Larsson acknowledges that "…the PLM system in particular needs to be better at keeping track of the total flow…", by which he means that it also needs to incorporate "…the recycling data, the re-flows and the data from the user phase as well as the end-of-life phase, in order to use the data in the design phase to improve decisions.". He further says;

> "The re-flow needs improvement in regards to how the products are designed to recycle, reuse and remanufacture, if they can be recycled within the already existing infrastructure, if the components of the products can be easily identified or if the parts can be easily disassembled.".

In IKEA's sustainability report (2015) it can be read that they believe it is necessary to engage the whole supply chain in order to reuse and recycle waste. Per Stoltz, Sustainability Developer at IKEA, explains that for a company that "…thinks circular…", it is necessary to work cross functional since the flows are passing everyone and every function. He further

says that the reverse logistics flow needs to be built up from scratch since it is a completely new flow. He means that they have to build up the infrastructure, the logistics and also the technology to some extent. This requires innovations and new ways of retaining the value in the material, Per Stoltz explains. He states that in the reverse logistics processes,

> "IKEA needs to develop a system that can track what is happening within this flow. The system needs to be able to answer the questions of where they can find the flows and the material, how these should be handled, how these should be measured and qualified in terms of their requirements and what these flows look like between the actors.".

Today, at some of the interviewed companies, IT is not incorporated in the organization as much as it could be. Emma Enebog, Chairman of Cradlenet and Head of Sustainability at Myrorna informs that "…today Myrorna uses Excel sheets to handle all information but in a long-term perspective, it is likely that we need a more advanced system.". She concludes that they, to date, "…have not been mature enough to know how to invest in system-support as well as Myrorna lacks the capital to do so.". She adds that it requires a holistic view of the organization and its processes in order to get value from system-support. Similarly, Lena Törn, Purchase Developer at Lindex, says that their system needs to be more global and transparent. She says that "…today they work a lot within Excel which is not the optimal solution for a global company.". Also MQ confesses that they handle some of the processes related to the product Lifecycle in Excel. Helen Göthe and Eleonor Björserud, both CSR and Environment Responsible at MQ, state that they are working on creating a more holistic system that can map their orders. They further believe they "...need an integrated system with linked information from across the supply chain.".
The Quality Strategist and The Sustainability Strategist at Company X state that their PLM system is only used for the birth of the products but they both see a possibility to also incorporate spare parts and reverse logistics into the system. They mention that the company's after-sales, the collection of used products, is not incorporated in the system today and that the company plan to include those responsible for aftersales in the system in order to let them decide where the product collected after sale should be sent, in order for a more efficient handling of the re-flows. In terms of incorporating IT in reverse logistics, Mats Linder, Project Manager at The Ellen MacArthur Foundation, states that IT can facilitate easy and trustable transactions in the whole value chain and specifically in reverse logistics since these flows involve many transactions. He mentions BlockChain[24] as one potential technology to do this, which "…allows for reliable transactions without the need for involving a third-party bank, cards and interfaces but with full transparency.".

[24] Block Chain is packages (blocks) which contains data, stored in a chain (Technology Trends, 2016). Each block of data draws information from the previous block which ensures reliable data and the blocks are digitally recorded (ibid).

4.5. Barriers in a Wider Perspective

All interviewees express that the transition to the new economic model of circular economy is lined by difficulties, hinders and barriers. It is explained that circular economy is a complex concept that requires big changes, not only related to the business processes within a company. To illustrate, Lena Törn, Purchase Developer at Lindex, describes this complexity in her interview by drawing upon Lindex' initiative within circular economy. She explains that Lindex' Re:Design project was outside their regular working process meaning they encountered problems within accounting, legal requirements and the systems used. She concludes that "…the extra handling of the products added extra costs and cannot be a manual process if the project were to scale up and be economically viable.". She means it is evident that in order to scale up the project, it is necessary to "…make big changes to the system…". Below, some of the hinders and barriers that were highlighted recurrently throughout the interviews are presented, with the reservation that not all barriers that were touched upon in the interviews are discussed in the thesis.

4.5.1. Policies

Fredrika Klarén, Sustainability Manager at KappAhl, says in her interview that they need to have better conditions from the municipalities in order to create a comprehensive system of collecting used clothes. She means that "Regulations are necessary in order to create incentives to change.". Per Stoltz, Sustainability Developer at IKEA, believes that the transition to a circular economy requires a change in politics and society. Fjällräven's Sustainability Manager, Christiane Dolva, gives an example of this when she describes that Fjällräven has had problems with laws and regulations regarding how they can handle their waste from production. Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, states that "Businesses are in general ahead of governments in terms of sustainability questions.".

Marco Moro, Editorial Director at Renewable Matter, states that one of the main obstacles towards a circular economy is policies. He specifically emphasizes that EU's definition of the status of waste, impedes the transition to a circular economy. He further argues that the construction waste in Italy is a huge source for circular economy but that at the current state, it is impossible to use it within the circular economy because of the regulations present. He exemplifies that Italy has a 10 per cent recycling rate compared to Netherlands' rate of 90 per cent, which he means is a result of the better conditions from the municipality in the Netherlands. Mats Linder, Project Manager at the Ellen MacArthur Foundation, also emphasizes the necessity of policies to create incentives to make the transition towards a circular economy.

4.5.2. Size of The Company

Some interviewees emphasize the size of the company as affecting the transition to a circular economy. Catrine Marchall, Sustainability Manager at Stadium, argues that "It is harder for a company like Stadium, with many different types of products including 50 per cent external brands, to achieve products that are 100 per cent circular in comparison to a smaller company.". She means that Stadium needs to take in consideration a lot of different aspects because of the size and assortment. Even though she says that "Circular economy is the right way to go.", she believes that companies need to find their own way of reaching a circular economy, since the business models often differ. To add, the CEO of MUD Jeans, Bert Van Son, thinks that it is a difficult move going from linear to circular but he believes that MUD Jeans has some benefits from being a small start-up company. He explains that the small sizes of their collections as well as their slow fashion allows them to be more sustainable since huge collections that offer the customers the latest fashion fast fashion, is hard to match with sustainability.

4.5.3. Changed Consumer Habits

Several of the interviewed emphasize the need for changed consumer habits and customer perceptions in order to make the transition towards a circular economy. Fredrika Klarén, Sustainability Manager at KappAhl, explains that "The research on this issue needs to scale up and the consumers also need to take part in the transition.". Mats Linder, Project Manager at The Ellen MacArthur Foundation, underlines that "Specifically within the clothing industry, changed user models are necessary in order for circular economy to evolve.". He emphasizes the importance of having customers that demand circular products in order for the circular economy to spread.

Per Stoltz, Sustainability Developer at IKEA, says in his interview that IKEA's customers do not value circularity as a factor today but that it is important to change the relationships between the customer and the business when moving towards circularity. He states that "…it is IKEA's role to spur that change.". Patagonia also sees it as their mission to create awareness among their customers according to their Environment and Social Initiatives Manager, Mihela Hladin. She explains that they drive a truck collecting used clothes as a marketing campaign to raise awareness of circular economy and sustainability. Furthermore, Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, states that in order for companies to go circular, "…it is necessary to make the move in such a way so that it is relevant for their customers…" and he means that companies do not do that today.

Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, labels the change towards a more sustainable and circular fashion as a "cultural change". He means that the customer perceptions have changed in the industry, relating to how the perception of the concept of fast (unsustainable) fashion has changed from "…having a positive notion to being loaded with negativity today.". In addition, changing linear business models into

circular business models also implies that the communication with the customer needs to change, according to Per Stoltz, Sustainability Developer at IKEA and Bert Van Son, CEO of MUD Jeans. Per Stoltz describes that when selling a service instead of the product, it requires more extensive communication. Bert Van Son also implies that is the case when leasing products.

Associate Professor Jonas Larsson furthermore believes that it is necessary to "…educate and communicate to the customers how they should use the products in order for the re-flows to work.". Mats Linder, Project Manager at the Ellen MacArthur Foundation, however denotes that it is complex to communicate the concept of circular economy to the consumers. On this topic, Lewis Perkins, President of Cradle to Cradle Product Innovation Institute, says that technology can be used to incentivize the consumers to change their habits, for example to return their clothes. He explains that "…technology can be used to gamify, and make it fun and easy for consumers to shift.".

4.5.3. Company Culture and Change Management

Many of the interviewed describe that changing the culture of the company is one of the main obstacles towards the change. Lena Törn, Purchase Developer at Lindex, says in her interview; "When moving towards more circularity by not using new, fresh material, changing the mindset of all involved can be one big issue that needs to be considered.". Catrine Marchall, Sustainability Manager at Stadium, agrees that it is difficult to incorporate circular economy in a company that has traditionally been linear. Mats Linder, Project Manager at The Ellen MacArthur Foundation, proclaims that it is necessary to have a leadership that dares to question the old culture and old incentive systems and that understands what needs to be optimized, when moving to a circular economy. Mihela Hladin, Environment and Social Initiatives Manager at Patagonia, informs that Patagonia constantly remind themselves of the intention of the company and that it is necessary to "…go the extra mile…" in order to solve problems relating to sustainability. She means that the culture of the company is very important in these matters.

4.5.4. New Measurements and KPIs

The interviews describe the necessity of changing measurements and KPIs in the company, in order for a successful move towards circularity. Per Stoltz, IKEA's Sustainability Developer, thinks that IKEA needs to change the way they make decisions in order for a successful move to a more circular model. He describes it as they need to "…rearrange how they value different factors and think, in terms of sustainability and economic value as well as both long term and short term.". Similarly, Fredrika Klarén, Sustainability Manager at KappAhl, expresses that "It is necessary to implement new ways to measure the financials of the product since the way we calculate profit and assets do not work today.". She concludes that "The calculations need to be applied to the new ways of working with sustainability.".

Also Mats Linder, Project Manager at The Ellen MacArthur Foundation, emphasizes that today, it could be necessary for companies to rearrange the structure of KPIs and incentive systems in order to measure progress in a circular economy. He argues that only basing decisions on price does not work in the current setting since factors such as environment, health and ecosystem services are not priced accordingly. He says that all functions in a business need to incorporate all important parameters when making decisions, meaning that in a circular economy, "…you need to question what parameters the decision makers base their decisions on and what incentives they have.".

Associate Professor Jonas Larsson, also argues that the businesses today consider price primarily and that in order for a circular economy to work, it is necessary to consider other factors as well. Jonas Larsson furthermore highlights the need for new measurements for measuring success in the new flows of circular economy. As an example, he says that it is necessary to reconsider the measurements that are based on the usual consumption's use and investigate if they are relevant for reverse logistics and the processes of up-cycling.

4.5.5. Investments and Risk Management

Emma Enebog, Chairman of Cradlenet and Head of Sustainability at Myrorna, believes that "We still have a long way to go towards a circular economy.". She thinks that there are a lot of questions that need to be answered and that "…more promoting and pushing towards the right direction is needed.". She says that finance has an important part in promoting sustainability in industries and Emma Enebog believes that investments in sustainability are needed in order to secure the future. She thinks that "The circular economy needs to get a spot in the board room. Those who are business developers and innovators need to start thinking circular. If people with that type of competence would value circular economies, things would start to develop quickly.".

Lewis Perkins, President of Cradle to Cradle Product Innovation Institute, also discusses the investments in circular economy in his interview. He believes that convincing the investment community of the value of circularity is a difficult process. He explains that "Even though it is understood that the take-make-dispose model does not work, it still has a lot of money attached to it and circular economy disrupts the old system whereby investors see it as risky.". Lewis Perkins means that it is necessary to put a value on that risk. He proclaims that "We need to start to put a value on the planet, and the costs associated with the negative externalities. We need a green valuation on societal impact and not only a valuation of the price point.". In a similar manner, Mats Linder, Project Manager at The Ellen MacArthur Foundation, thinks that risk management is hard to quantify. He means that there is a need for a stronger strategic aim when it comes to circular economy.

4.6. Circular Economy in Different Industries

Several of the interviewees highlight that other industries than the fashion and textile have great potential of transitioning toward circular business models. They discuss different aspects and pre-requisites that affect how easily companies within different segments could make the transition. Mats Linder, Project Manager at The Ellen MacArthur Foundation, explains that he sees it as a two-dimensional graph, see figure 4.3, where the consumer industry is at the far left of the x-axis and building and infrastructure industry to the far right. The y-axis is an index of how easily implemented the circular models are. He adds that the middle of the graph is the so-called window of viability. He explains that "The eye of window is made up of products such as electronics, vehicles, industry machines and things that are built to be robust, worth of repairing and thus already incorporate a circular thinking.". To the left, there are home electronics, computers and mobile phones. Mats Linder means that the technical development in this segment is rapid but the value of the materials is oftentimes longer than the products' lifetimes. He says that "I see a lot of opportunities in this category if the design of the product is changed.".

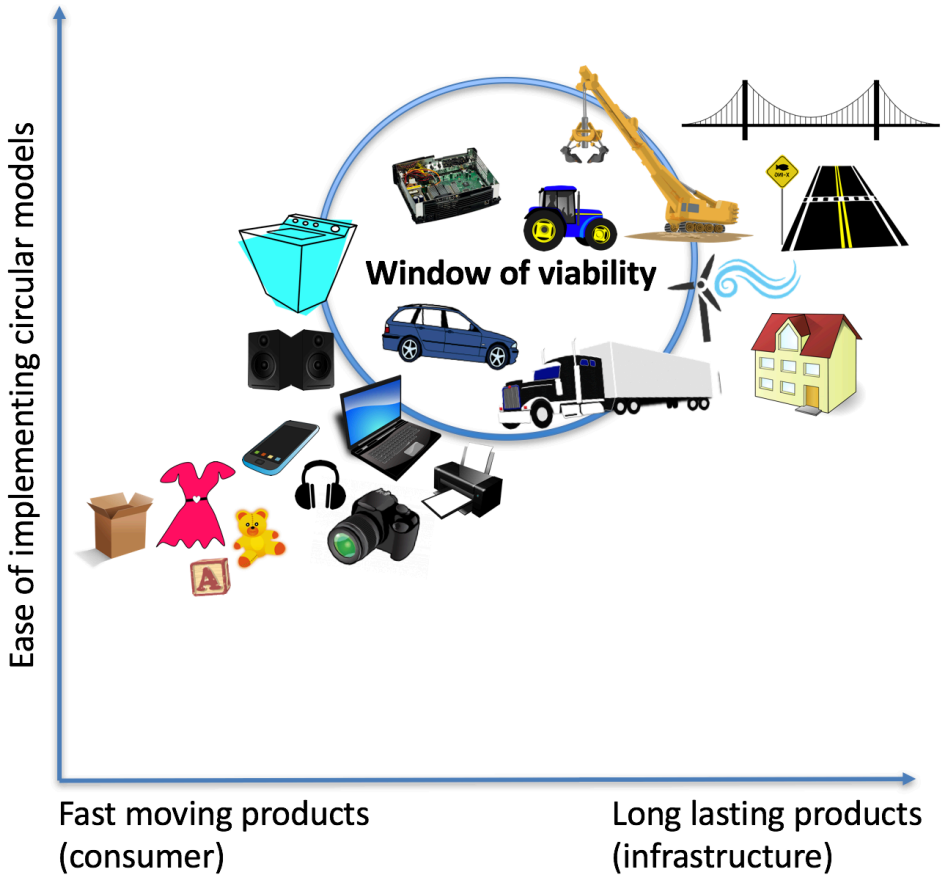

Figure 4.3. The figure illustrates the authors' interpretation of Mats Linder's, Project Manager at The Ellen MacArthur Foundation, description of how easily implemented circular models are within different industries.

In a similar way, Emma Enebog, Chairman of Cradlenet and Head of Sustainability at Myrorna, sees opportunities within the electronics industry due to the high value and high price of the products. She compares it with the fashion industry referring to the fashion industry's low-price products and says that "…the prices within fashion might impede the development of circular products since circular products tend to have a higher price.". She also says that the complex logistics of the fashion industry implies that it is harder to move towards circularity in comparison to the electronics industry. She indicates that she is surprised that the electronics industry has not come further in their development towards circularity. Lewis Perkins, President at Cradle to Cradle Product Innovation Institute, agrees with Emma Enebog stating that he believes that electronics has a stronger need than other industries of changing towards more circularity. He explains the reason to be the high value of metals and plastic and the higher price of the products in this segment. Lewis Perkins on the other hand also believes that the building industry has potential to make the transition to circularity. He remarks that the building industries are "…investigating material banks and how to design for circularity within a building system.".

Associate Professor Jonas Larsson does not emphasize one particular sector to have extra potential going circular but instead suggests that all sectors who have some sort of production need changing. He states that: "Naturally, you need to bear in mind that resources are scarce and that you shouldn't pollute.". Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, discusses how the move to circularity is different depending on industry. He explains that while investigating how furniture companies can transition to a more circular business model, he noticed that the applicability of the findings depends on the rules of the specific industry since the specific industry affects the companies' possibilities to transit towards circular business models. He therefore believes that the findings of his study cannot be applicable to other industries. He also adds that in their study they worked differently with different companies because they had different business models.

5. Analysis

The following chapter analyzes the findings together with the theoretical framework with the aim of answering the research question of how a PLM system could enable circular business processes. However, the analysis is twofold since the empirical findings showed that, in order to answer the research question, it became necessary to dig deeper into other domains outside the IT system's range. One common factor between all interviewees was that they all touched upon, or emphasized, the importance of other factors than business processes and IT systems when moving towards a circular economy. Thus, the outline is as follows. The analysis starts with illustrating the urge of change on a global level, it thereafter illuminates the ongoing transition where after it emphasizes the shift's complexity. Thereafter the analysis focuses on the research question at hand, analyzing the problems with the changed business processes, the IT systems, PLM, and also specific tools that could enable the move when being incorporated within the PLM system. Finally, the thesis takes on a wider view of the transition. The findings of the interviews are presented in table 5.1.

Table 5.1. The table presents the findings of the interviews. The findings are represented with numbers for easier illustration. However, it does not necessarily mean that the findings depend on the former, that they are chronologically ordered nor does the number indicate the level of importance.

Findings		
No.	**Finding**	**Description**
1.	Unsustainable businesses	We need to change the way we run our businesses to a more sustainable setting.
2.	Shifting mind-sets	The mind-set of the textile industry is beginning to shift.
3.	Need for tools and enablers	There is a lack of tools and enablers to support the transition.
4.	Unsupportive IT systems	IT is necessary to enable the shift but the current IT systems do not support companies' green processes related to the product Lifecycle, in a satisfying way.
5.	Need for changed business processes	One necessary change to make in order to become more sustainable is changing the business processes related to the product Lifecycle.
6.	Lack of information	The most stressing issue with the changed business processes is the lack of reliable sustainability information in order to make informed decisions based on sustainability.
7.	Enabler: Sustainability indexes /scorecards	A sustainability index and/or scorecards could enable gathering more reliable sustainability information in the design phase.
8.	Enabler: IT- driven tag	An IT-driven tag could enable gathering more reliable sustainability information in the end-of-life phase.
9.	Complex move	The move towards a circular economy is complex and implies several obstacles that need to be overcome.

5.1. The Transition to a Circular Economy

Relating to the finding (1) Unsustainable businesses, the urgency of change towards a more circular economy within fashion, is pertinent throughout the study. The H&M Foundation noticed the unsustainable businesses of today and stated that; 'In order to create a sustainable fashion, it's impossible to go on shipping, selling and consuming clothes in a linear mode.' (H&M Foundation 2017c, 34). Facts that illustrate the potential of the circular economy within fashion were illustrated by The Circle Textiles Program (2017) which stated that 20

million tons of textiles are landfilled or incinerated each year in the EU and US alone whereas 95% of all these textiles, could be re-worn or recycled. Also, the interviewed had clearly noticed the issues of their unsustainable businesses and finding (2) Shifting mind-sets, shows that they are actively seeking for a change.

To repeat the background of finding (2) Shifting mind-sets, IKEA started the "Circular IKEA" concept, Lindex started to recollect garments and initiated, in the spring of 2016, an up-cycling initiative. Fjällräven works on reusing production spill material and aims towards collecting and up-cycling used clothes as well as production spill and Stadium has collected and donated used clothes since 2003 in collaboration with Human Bridge. Also KappAhl recollects used clothes since 2015, and they stated in their latest sustainability report that they want to "…increase the reuse, upcycling and create a comprehensive system of collecting used clothes.". In addition, those companies that are already based on a circular way of doing business; Sellpy and Myrorna that sell second hand products, Pure Waste which produces products from waste materials, MUD Jeans which leases their products, and finally Patagonia that has several circular initiatives, all imply the changed mind-set and the potential of transitioning to a circular economy. Hence, when considering the interviewed companies in this thesis, the Project Manager at The Ellen MacArthur Foundation, Mats Linder's statement that it is difficult to have a strategy that does not involve circular economy today, seems valid.

To add, finding (2) Shifting mind-sets, is in line with the research of TU Delft (2017) that found the mind-set of the textile and fashion industry and its businesses is beginning to shift from linearity to circularity. This is a sign of a positive attitude towards a change. It further implies an increasing adaptability in this industry and shows that the transition towards a circular economy in the industry of fashion could potentially be within reach. Thus, the findings might imply that if or when there is an adaptable and functional process and/or system in place for circular economy, the textile companies are both aware of many of the benefits with the circular model as well as aware of the stressing need for change. However, finding (3) Need for tools and enablers, shows that support is necessary to enable the transition. Mats Linder, Project Manager at the Ellen MacArthur Foundation, said in his interview in terms of the tools of circular economy; "...someone needs to develop something that actually works.". This statement emphasizes the relevance of this research. To conclude all of the above, one might argue that when the tools enabling a circular economy are available, fashion and textile is an industry that will use them.

5.1.1. The Product Lifecycle and IT

The theoretical- and the empirical framework are aligned that IT is an important tool to enable circular processes, to the point that it can be argued to be crucial. As Stuchtey et al. (2016) wrote, the integration between technology, economy and environment is crucial to get right in order to reap the benefits of a circular economy. Nevertheless, this fact makes it more alluring when the empirical study clearly indicates that the IT systems today are not supportive

enough, relating to finding (5) Unsupportive IT systems. Sarkis and Zhu (2008) concluded in their study that the integration with IT systems, Lifecycle analysis as well as design for environment tools is inadequate today and needs further study. All this implies that there is both a need and an opportunity for IT to enable more sustainable processes.

In terms of PLM as a supportive IT system, Storvik, CTO of TechniaTranscat, stated in the theoretical framework that PLM is central in order to achieve a closed loop circular economy since it contains the definition of the product. Several of the interviewees agreed that PLM and sustainability could go hand in hand. As an example, Lena Törn, Purchase Developer at Lindex, stated that "The ability to incorporate tools that can facilitate our work within sustainability, is one of the aspects we value in our new PLM system.". Helen Göthe and Eleonor Björserud, both CSR and Environment Responsible at MQ, agreed but stated that their current PLM system is not optimal in terms of how it supports the decision making in their green processes. This implies that in order to enable the transition towards circularity, one way is to adapt and/or extend the scope of the PLM system, which according to most of the interviewed, is wanted.

Another aspect endorsing that PLM could be a helpful tool in the transition to a circular economy is Jun et al.'s, (2007) statement that Closed Loop PLM could also be used to increase transparency and information sharing. This relates to finding (6) Need for changed business processes. All interviewees described how the business processes need changing in terms of sustainability. They agreed that they need to improve transparency and information sharing. However, the transparency and information sharing were also some of the biggest issues that they faced. They all described that there is a lack of transparency and information regarding sustainability data today. Hence finding (7) Lack of information.

5.2. Lack of Reliable Sustainability Information

In order to enable changed business processes within the product Lifecycle, the companies need to be provided with reliable sustainability information. It can be depicted that the information is necessary in order for informed decisions in all phases of the Lifecycle and to achieve an increased transparency of the business. Senior Consultant and Sustainability Strategist at IPM Ulricehamn Marcus Bergman, illustrated the problem that all interviewed companies face when he said that "The big sustainability issue in the textile industry is that the raw material industry is completely anonymized and changing this is a big industrial transformation.". Deloitte (2012) stressed the relevance of the issue when they predicted that the customers of the consumer and retail companies will require an increased transparency in the near future.

However, one might argue that the industrial transformation Marcus Bergman talked about has already begun since all the interviewed were aware of their lack of information and have started to investigate how they can decrease their knowledge gap. The interviewed companies

have developed, started to develop or already use tools for tracking sustainability information of; materials, production processes, (hazardous) chemicals used in the production or in the materials, and of suppliers. With that being said, the issue of not having the right reliable information is at present obvious among the companies. The empirical framework thus denotes that the lack of reliable sustainability information creates problems when moving towards, and enabling more circular processes. In table 5.2, the interviewees perceived consequences of not having the right reliable sustainability information is presented. In the following sections, the specific problems of the lack of reliable sustainability information, in what phases in the Lifecycle that the problems occur, and how it could be solved, are analyzed.

Table 5.2. The table describes the respondents perceived consequences of finding 6. Lack of Reliable Sustainability Information, in the design- and end-of-life phase.

Finding 6. Lack of Reliable Sustainability Information	
Phase	**Consequence**
Design	Uninformed decisions Lack of transparency Impedes circular design Lack knowledge of environmental impact
End-of-life	Impedes circular design Lack knowledge in how to handle used products

5.2.1. The Product Lifecycle - The Design Phase

As an example of where in the product Lifecycle there clearly is a lack of reliable sustainability information, is in the design phase of the product. The companies said that they lacked the data of the environmental impact of different materials and processes to base decisions on in the design phase. As mentioned in the theoretical framework, it is important to make the right decisions in the design phase of the product in order to minimize negative effects derived from the whole product Lifecycle, designing out the waste and achieving the circular processes such as reusing, recycling and cascading (Zhijun & Nailing, 2007; Ellen

MacArthur Foundation et al. 2015). Several of the interviewed currently investigate how they can gather data and improve their decisions based on sustainability.

The abovementioned thus implies that making the right decisions based on the right information in the design phase is crucial in order to make the transition towards a circular economy and the information is not only needed to improve decisions of what is the most sustainable materials to use, but also to improve or enable designing the products for circularity, as well as to increase the transparency of the business. Some of the interviewed have already started to consider designing the products for circularity, such as IKEA, which according to their Sustainability Developer Per Stoltz, "...needs to rethink the process and move from design-to-recycle towards design-to-circularity.", and also Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, investigated in his project with different furniture companies, how they could start designing for reuse.

Many of the clothing companies interviewed do not possess the information required to design for circularity and to make decisions based on reliable sustainability information today, and they feel there is a lack of tools and aids to enable the transition. Hence, a tool that facilitates these decisions and provides reliable sustainability information could facilitate reaching a circular economy. Several of the interviewed discussed tools such as indexes and assessments as enabling gathering this data. Lewis Perkins, President of Cradle to Cradle Product Innovation Institute, stated that in a circular economy, the companies need to be able to base decisions on data in order to know what material to choose in the design phase.

Likewise, Franconi et al. (2016) highlighted the need for tools such as metrics in order to make better informed decisions based on sustainability and measure the circularity of the product. They also said that measurements such as Lifecycle Assessment, carbon footprint and other indexes are helpful both in terms of increasing the transparency towards the consumer as well as in the internal business, and in order to gather right and reliable information to improve decision making, as well as to pinpoint areas for improvement. Hence, a conclusion is that there is a need for some sort of index or tool that provides the data that the companies lack in order to enable the transition towards a circular economy.

5.2.1.1. Enabler: The Higg Index in PLM

The index that was mostly discussed among the interviewed companies active in the textile and fashion industry was The Higg Index. Based on the interviewed companies, the ones already using The Higg Index are Pure Waste, Patagonia and Fjällräven. The companies interviewed that do not use The Higg Index today but investigate incorporating it in the future are Stadium, MQ and Lindex. As can be read in the literature study, the members of SAC, the organization who developed The Higg Index, today produce around 40 percent of the world's output of apparel, footwear and home textile (Patagonia, 2015). The size indicates the potential spread of the tool. Since The Higg Index take in consideration different aspects within the product Lifecycles and facilitates making correct informed decisions based on

sustainability information, it is considered a suitable tool to use in order to facilitate the move towards a circular economy in the fashion industry.

The interviewees discussed the benefits of using The Higg Index as not only increasing the reliable sustainability information, but also allowing for a more transparent business and a more transparent communication to the consumer. However, the interviewees also discussed the problems with this index, stating that it is a complicated tool, in need of a lot of input data. Several saw the potential of incorporating the tool within an IT system to decrease the complexity of using it as well as to allow for only using one system for keeping track of the processes related to the product. Also Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, said that The Higg Index is a complicated system that requires a lot of resources and knowledge whereby he thinks it is necessary to integrate it into a company's current IT system.

Marcus Bergman however emphasized the importance to "…not just build another layer of sustainability system on top of the enterprise system…" and Lena Törn, Purchase Developer at Lindex, agreed that it is necessary to link, for example, the PLM with other systems such as the designer's Adobe Illustrator system. Helen Göthe, CSR and Environment Responsible at MQ said that they require a holistic system that allows for different functions to communicate and share information. Hence, if The Higg Index could be incorporated in the IT system and linking it to other systems as well so that it can be used by all involved, it could increase the ease of using the tool and increase the internal transparency of the business. The abovementioned implies the need for an easy-to-use, easy-to-visualize integrated system for The Higg Index.

Associate Professor Jonas Larsson stated in his interview that he thinks there will be several different tools similar to The Higg Index that will also be based on Lifecycle analysis and that are adjusted to different types of businesses. Lewis Perkins, President at C2C Product Innovation Institute, also talked about the many different similar assessment tools that exists today and stated that these tools need to start to communicate with each other. As mentioned in the theoretical framework, another Lifecycle assessment index is Cradle2Cradle certified products program which could potentially also be incorporated within a PLM system.

The findings of the interviews together with the theoretical framework, show that the modules available within The Higg Index, especially the MSI and the DDM, is preferred to use as decision basis for sustainability in the design phase for fashion and textile companies. Several of the interviewed also see the possibilities of incorporating these modules in an IT system such as a PLM system. Incorporating The Higg Index within PLM could decrease the gap of reliable sustainability information that all of the interviewed companies feel exist today as well as facilitate the use of the tool for the companies. Thus, The Higg Index could facilitate the move towards circular economy for the interviewed. However, it can be derived that the complexity of using the tool implies that it is necessary to create or incorporate it into a

system that is easy to use, easy to visualize, linked to other systems, and adapted to the user of the tool.

5.2.1.2. Enabler: Scorecards in PLM

Several of the companies interviewed use individually developed scorecards, adapted to their specific business. IKEA, KappAhl, Lindex MQ and Patagonia all use scorecards. Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, described in his interview the importance of having scorecards adapted to the specific business in order for the scoring to be valuable. It can be derived from the empirical findings that, if the scoring is easily understood, the scorecards enable making decisions that considers several different aspects of the product, such as functionality aesthetics, price and sustainability of the material as well as it could help make the most sustainable decision regarding choice of supplier or transport. Furthermore, it is evident that the focus on sustainability cannot impede other factors for the companies going from linear to circular. Per Stoltz, Sustainability Developer at IKEA and Mihela Hladin Environment and Social Initiative Manager at Patagonia, stated that they have to retain their focus on all other aspects and not fail in one area because of too much focus on sustainability.

One conclusion from the study is that in order for enabling the move towards more circular business processes, it is necessary to incorporate measures within the scorecards that traditionally has not been scored in the linear model. As an example, As Head of Sustainability at Gina Tricot, Marcus Bergman described how he incorporated the measure of how well the product sells in the store, so that it could be levelled with the other indexes and thus provide a more holistic perspective of the total sustainability level of the product including the sustainability impact of pushing products to the market, eventually producing a large amount of deadstock each season. Also Franconi et.al., (2016) emphasized the importance of measuring other aspects in a circular scenario. They gave the examples of measuring how much of the products are kept in use for longer and how many products that goes to reuse or recycling.

Several of the interviewed aimed to incorporate the scorecards in their PLM system to provide an index per product and improve the decisions based on sustainability information. Since the PLM system usually facilitates the processes around the design and product development phase, the user would directly link the sustainability tools to the processes within the product Lifecycle and thus provide an index per product. To exemplify, Helen Göthe and Eleonor Björserud, both with the title of CSR and Environment Responsible at MQ, stated that incorporating a scoring in the PLM system would enable them to directly steer the procurements towards the more sustainable supplier. The findings thus show that it is important to incorporate the scorecards within an IT system and specifically a PLM system to facilitate and standardize the use of these measures within an organisation. Based on the abovementioned, using internally configured scorecards could enable the move towards a

circular economy by providing sustainability- (and other) information based on company derived standards. This would allow for making more informed decisions based on several different factors of the product and its lifetime, thus enabling more circular products.

5.2.1.3. The Higg Index and Scorecards

Both The Higg Index and Scorecards could be used to gather the right reliable sustainability information to enable making the right decision based on both sustainability and other aspects. To explain, the intention of the scorecards is lost if there is no information to score on. As an example, KappAhl only scored two factors due to lack of information to score other factors. It is crucial to have the right information (The Higg Index) and level this information in relation to other important factors (scorecards). Hence, incorporating both tools could be beneficial in a circular economy. One could draw the conclusion that the many members of SAC can share the burden of developing new standards for information demanded from upstream suppliers.

Relating to Franconi et al. (2016), they stated that in a circular scenario the metrics should enable designers to choose the most sustainable option in the design stage and it should allow for both comparing products as well as for deciding minimum requirements for the products bought. Also this statement enforces that both scorecards and The Higg Index are viable tools to use and could create even more value for corporations when used together. The empirical framework also indicates that the scoring needs to provide easily understandable information adapted to the specific business and that different companies value different aspects in terms of the sustainability of the product. This however contradicts applying one generic tool for an entire industry, such as The Higg Index and thus enforces Fredrika Klarén's, from KappAhl, belief that it is hard to incorporate a tool that is generic and applicable to all companies. She stated that it is necessary to; "…have your own process based on your own values, but complementing this process with other tools.". This also enforces the use of both scorecards and The Higg Index.

5.2.2. The Product Lifecycle - End-of-life phase

In the empirical framework, Associate Professor Jonas Larsson pinpointed the end-of-life phase as especially important to incorporate measures within and gather information of, in order for a successful transition towards a circular economy. He claimed that, it is necessary in order to take in consideration a holistic view of the sustainability of a product in a circular scenario. The problems with the lack of information in the end-of-life phase are analyzed from the empirical- and theoretical framework to be;

(i) *Designing for circularity*; it impedes designing for circularity.

(ii) *Knowing how* to *handle used products*; it hinders companies to know how to take care of the recollected products.

Problem (i) Designing for circularity, means that the inability to gather information about the products in the end-of-life phase also affects the ability to make the right decisions in the design phase and thus also impedes the design for circularity. The theoretical framework emphasized that the design phase is crucial in a circular economy since it is necessary to design the product to its intended use, design out the waste as well as adapt the product for a longer life and several Lifecycles (Lieder & Rashid, 2015). The Ellen MacArthur Foundation (2015) stated that it is important to focus on the end-of-life already in the design phase. In order to do this, Associate Professor Jonas Larsson meant that gathering information in the end-of-life phase will allow for a better and more circular design in the design phase. Thus, the inability to gather the right information in the end-of-life phase will impede the designing for circularity. TU Delft (2017) highlighted how the end-of-life processes such as remanufacturing can be made more efficient if it is considered already in the product design. This shows the importance of gathering information in the end-of-life phase.

Relating to problem (ii) Knowing how to handle used products, several of the interviewees that had worked with reverse logistics experienced the problem of not knowing how to best handle the recollected products in the end-of-life phase. They described the reason for the problem to be the inability to track the information of the recollected products. They said that they need the information about the product and the material in order to know how to handle it, how to sort it, how to take it apart, how to collect it and how to recycle and/or upcycle it. Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn was one of the interviewees who described the importance of knowing how to handle the products in reverse logistics in his interview. He said that the process of taking back the products is one of the main obstacles for companies within consumer and retail going circular today since the companies do not know when to reuse and when to recycle. He also added that the aspect of how the products have been used and what they have been exposed to is important data to base the decision of how to handle the material on. He stated that this data is impossible to track today.

The importance of gathering information in the end-of-life phase is also highlighted in the theoretical framework. The Ellen MacArthur report Intelligent Assets (2017), argued that when companies are choosing the next use cycle for the returned product, lots of information is necessary and several factors need to be considered in order to decide whether to reuse, remanufacture, recycle or refurbish. The information necessary to choose whether to reuse, recycle into new products, use for energy, waste dumping, i.e. end up in landfill, are decided by; quality, condition and fashion accuracy of the garments according to Palm (2011). Thus, the empirical findings together with the theoretical framework show that gathering and storing data about the products and its material is crucial in order to take the necessary decisions when handling products after its first intended use. Furthermore, in this scenario, The Ellen MacArthur Foundation et al. (2015), describe the importance of having “cost-efficient, better-quality collection, treatment systems and effective segmentation of end-of-life products” in order to achieve a circular economy. They mean that efficient segmentation of end-of-life

products implies that each material can be reused in the most suitable and high-value application, this is described in the theoretical framework by Stahel (2016) as the "inertia principle".

Relating to both problems (i) Designing for circularity (ii) Knowing how to handle used products, Catrine Marchall, Sustainability Manager at Stadium acknowledged in her interview that they would need to include a measurement for the end-of-life phase in order to know how to handle the product as well as how to design for a better circularity. In this way, she meant that these measurements could be used for making better decisions both in the design- and in the end-of life phase. Catrine Marchall furthermore emphasized the need of incorporating those types of measurements within the PLM system. Also Lieder and Rashid (2015) emphasized the importance of providing information of the products in both the design phase and in the end-of-life phase. They argued that reusing, upgrading and refurbishing do not only require another construction of the product, they mean it is also necessary to incorporate information in the product somehow, from the very beginning. In this way, they claimed that the information incorporated already in the design, could later on be available to those involved in the maintenance and in the reverse logistics, enabling efficiency in these processes.

In relation to this, also Associate professor Jonas Larsson acknowledged that

> "The re-flow needs improvement in regards to how the products are designed to recycle, reuse and remanufacture, if they can be recycled within the already existing infrastructure, if the components of the products can be easily identified or if the parts can be easily disassembled.".

He further added that "…the PLM system in particular needs to be better at keeping track of the total flow…", by which he means that it also needs to incorporate "…the recycling data, the re-flows and the data from the user phase as well as the end-of-life phase, in order to use the data in the design phase to improve decisions.".

The abovementioned implies that problems (i) Designing for circularity and (ii) Knowing how to handle used products, both need to be solved in order to achieve a closed loop and a circular scenario. The above analysis thus shows that the design- and end-of-life phase are interlinked and dependent on each other in the circular model. It can be argued that achieving circularity requires a holistic view of the whole loop and thereby the total sustainability of the product. Conclusively, in the circular model, one cannot simply consider the birth of life without considering the end-of-life and vice versa.

5.2.2.1. Enabler: Tracking materials and products with IT

In order to gather data in the end-of-life phase and solve the two problems of (i) Designing for circularity and (ii) Knowing how to handle used products, several of the interviewed proposed to apply a digital tag on the product that automatically could present the data of the

recollected garment in an IT system. These findings are also in line with the findings of the theoretical framework that

RFID, could provide the necessary information in the end-of-life phase. In the theoretical framework, the findings of the report by The World Economic Forum et. al. (2014) showed that Radio Frequency Identification (RFID) could be used to track the status and the location of the product. Knowing the status of the product, is stated by the report to allow for defining the formulation of the materials collected, something they meant is the key to enable circular flows. Both Mats Linder, Project Manager at The Ellen MacArthur Foundation and Lewis Perkins, President of Cradle to Cradle Products Innovation Institute, proposed in their interviews that an IT driven tag could be assigned to the products for the abovementioned purposes.

Furthermore, Mikael Arnör at Sellpy also saw the need of using tagged products in their circular business model. He meant that it could allow them to scan and gather all the information of the collected product from the manufacturer directly and he added that Sellpy currently investigates the possibilities of constant image-recognition to enable gathering the information of the products. Relating to the above stated, IT could be seen as an enabler for the move towards a closed loop model. Mats Linder, Project Manager at The Ellen MacArthur Foundation, emphasized in his interview the complexity of reverse logistics compared to the traditional forward logistics and explained that IT is crucial in order to get the re-flows to work. Fredrik Wallenholm at Allies, also emphasized the importance of IT in these situations and said that an IT system could help keep track of where the product is at all times. The report by The Ellen MacArthur Foundation (2016) stated that the connectivity will enhance the value that can be derived from circular processes as well as facilitate these, which is in line with the abovementioned.

Furthermore, the same report noted that the reverse logistics has a great need for a system that tracks the product, collects information of the condition of the product and the market situation, as well as an analytical model that uses the data, in order for the process of reverse logistics to work. The report also stated that gathering all this data will prove beneficial for the transparency of the business, towards the consumers as well as internally within the business. They meant that the data could be used in order to improve the quality of the product and product design, relating to problem (i) Designing for circularity. Increasing the transparency of the business towards the consumer was mentioned as important when moving to a circular economy by several of the interviewed. Moreover, The Ellen MacArthur Foundation (2016) found that knowing the condition of the product also allows for proactive maintenance. That is also one of the most efficient ways of prolonging the lifetime of the product in a circular economy, according to The Inertia Principle by Stahel (2016). Thus, if the system can signal when maintenance is needed, its life-time can be prolonged in an efficient way.

Accenture and H&M Foundation investigated the future prospects of circular economy within fashion (Olsson et al., 2017). One of the predicted trends was that new recycling methods would be created and another trend was that the reuse of clothes will increase. They further predicted that there will be "connected clothes" - enabling a better tracking of the garments' information and thus better informed decisions of what to do with the clothes when they are recollected after use, relating to problem (ii) Knowing how to handle used products, described in the previous section. Three out of five trends mentioned in the study all evolve around the reverse logistics and the afterlife of garments, denoting the importance of enabling efficient re-flows in the future as well as the necessity of developing tools and aids to facilitate the processes connected to the flows. Improving and enabling these processes is thus of high importance in order to enable the switch towards a circular economy.

Another issue with reverse logistics is presented in the literature study by The Swedish Environmental Research Institute (Palm, 2011) which described that the prime barrier for sustainable textile waste management in Sweden is economical and that recollecting clothes in Sweden has much higher labor expenses than when producing new clothes. This fact further implies the need for enabling economically efficient supply chains, something that according to the abovementioned could be done through the use of technology and IT. Persson (2016) further endorse such a statement by writing that in order for the Re-flows to work, sustainable and economically viable business models are necessary and Persson believes that digitization, Big data and IOT could enable that. Likewise, Lieder and Rashid (2015) stated that economically viable value recovery activities are needed in reverse logistics. They further claimed that an efficient closed loop supply chain requires methods that enables the businesses to handle the data related to the Lifecycle, implying that it could be beneficial to incorporate the data in an IT system.

Taking the above discussion into consideration, the benefits of using IT within reverse logistics and specifically the solution of having IT driven tags on recollected clothes are substantial and could be seen as a key to enable circular flows as well as circular designs. It could both facilitate the decisions taken in the design phase as well as in the end-of-life phase, since it would generate reliable sustainability information. Further, the information gathered would increase the transparency of the business. In addition, being able to gather the information from the tags, would allow for measuring and/or scoring also in this phase, adding to, and improving, the scorecards/indexes introduced in the former section as a solution to facilitate circular models. It would also increase the communication and feedback between birth and end-of-life. A PLM system that has the ability to incorporate those measures as well as keeping track of IT driven tags could thus facilitate the transition towards a circular business. To build upon what Lieder and Rashid (2015) said in the theoretical framework, there is a need for enabling the businesses to handle the data related to the Lifecycle if the closed loop supply chain is to work.

5.3. Analyzing the Enablers

When incorporating the abovementioned solutions within a PLM system (a sustainability index, scorecards, IT driven tags) it enables transforming business-as-usual operations as Bechtel et al. (2013) described in the literature study as necessary in order for a successful transition towards a circular economy. According to Bechtel et al.'s study, small and medium enterprises (SMEs) experience agreed that the administrative burden, i.e. the long and complex procedures of attaining certifications and meeting standards, is a common obstacle towards becoming more circular. This study indicates that when incorporating an index such as The Higg Index, or other types of scoring within a PLM system in an easy-to-use way, it would decrease the complexity of working with these certifications, indexes or tools.

Moreover, Bechtel et al. referred to the fields of eco-design, clean production and Lifecycle assessment as fields that when integrated into the linear model would transform the operations into circular ones. The authors meant that what hinder companies to integrate these processes is lack of technical and technological know-how. Since the above analyzed solutions within PLM, could improve the decisions made in the design phase, i.e. decisions regarding design, eco-design and clean production, at the same time as it is a Lifecycle assessment, the know-how Bechtel et.al described as necessary to have in order to not adopt the familiar linear technologies and business models, could in this way be offered to the company through its PLM system. Thus, it could be one way to enable the transition towards a circular economy.

Also, as previously stated, The Ellen MacArthur Foundation et al. (2015) meant that using IT systems enables; collaboration across the chains and across sectors, transparency and information sharing. These are all especially important aspects to address in a circular economy with new flows and new information needs. The possible benefits of incorporating a sustainability index, scorecards and IT driven tags within the PLM system for a company transitioning to a more circular economy, together with the fact that circular economy is gaining traction among consumer and retail, and manufacturing companies, implies the importance of the matter. This thesis shows that the circular economy is on its way and it indicates the necessity for PLM providers to gather knowledge and skills in a circular economy in order to stay ajour and meet the demands of their customers.

However, Storvik, CTO at TechniaTranscat, mentioned that the PLM system cannot solve the issues of transitioning to a circular economy on its own but that it is necessary to integrate with several other IT systems. This implies that incorporating tools into a PLM system that may facilitate some circular processes, as this study proposes, is only one step towards enabling the transition. This also relates to Erik Bang's, Program Manager at H&M Foundation statement in his interview, based on the entries from the competition Global Change Award. Erik said that "No single solution will make the world circular, but if brought together, several solutions would create a circular system.".

Moreover, the theoretical- and the empirical framework both denote that the PLM system is today foremost used in the birth of the product. However, the theoretical framework argues that in order to enable a closed loop, a PLM system also exploits information from middle of life- and end of life phase (Daaboul et al., 2016). Similarly, the empirical framework implies that it is necessary to also incorporate other parts of the product Lifecycle within the PLM system than the birth of the product, in order to enable the transition. As an example, The Quality Strategist and The Sustainability Strategist at Company X stated that their PLM system is only used for the birth of the products but they see a possibility to also incorporate spare parts, and after sales in the system, for a more efficient handling of their re-flows.

The abovementioned underlines that the three enablers, The Higg Index, scorecards and IT driven tags, could support a circular economy since the tools take in consideration, and provide measures in, different phases of the product Lifecycle. It endorses that it is necessary to measure both in the design- and in the end-of-life phase. Using the three suggested tools within a PLM could also solve the problem of connecting the information gathered in different phases, and in turn provide a holistic, easy to use, system and improve the product from the birth and adjust it to its end-of-life.

5.4. The Transition in a Wider Perspective

In a more holistic perspective, outside of the PLM system's range, there are thus of course other obstacles that the businesses face in their transition towards circularity. Merely altering the IT systems will gain little for the companies in their transition if not other, more stressing issues can be solved. Quoting Lieder and Rashid (2015) presented in the literature study they wrote that a successful move towards a circular economy implies a radical change in the way a business is run. They refer to changed business perspectives, technological perspectives as well as policies. In addition, the theoretical framework also presents change management barriers, lack of capital time and investment, lack of government support, lack of information about the concept of circular economy, lack of an information exchange system as well as too heavy administrative burden of green business practices as impeding the transition (Bechtel et. al., 2013). Further, The Ellen MacArthur Foundation et al. (2015) rank enabling conditions for a circular economy to be; (1) Education i.e. creating the needed skills, (2) Financing i.e. capital and risk assessment that can be enabled by governments underwriting risks with new business models, (3) Collaborative Platforms i.e. enabling collaboration across the chains and across sectors, (4) IT enabled transparency and information sharing as well as (5) New economic framework which changes the existing measurements of economic performance.

The complexity of the transition and the business changes are also seen in the empirical framework. The interviews did not only present the issues related to IT systems and business processes but they also provided an overview of the many obstacles companies today face and it is clear that it is not an easy transition. The conditions that the interviewees saw as obstacles towards a circular economy were depicted to be; policies, size of the company, changed

consumer habits, company culture and change management, new measurements and KPIs as well as investments and risk management. Thus, the theoretical framework and the empirical findings are in many ways aligned in terms of the obstacles impeding the transition towards a circular economy. However, this thesis also indicates that the move is on its way and that some of these hinders are already starting to get smaller, brick by brick, as governments take on the political barriers (European Commission, 2017; SOU 2017:22), consumers are predicted to care more about the origin of their products (Deloitte, 2012), and more and more companies take a stand and incorporate the concept in their strategies (Ellen MacArthur foundation et al. 2015) (also evident from the empirical framework).

Even so, this thesis shows the importance of taking into consideration all factors affecting the move and as circular economy is put on the agenda in more and more business-, political- and societal settings, it is just as important to spread knowledge about the hinders as it is to spread knowledge about the enablers. Relating to the PLM system once again, the abovementioned implies that in order for the system to be used in the most optimal way, it is necessary for all functions in the company to be aligned, work together and incorporate sustainability and circular economy within the company culture. Merely adding sustainability into the PLM might not imply that all business functions will actually use the data they are provided with. Also, if policies hinder the business processes to change, then the IT system enabling the processes might be irrelevant.

6. Discussion

Below, the applicability of the findings, as well as other possible solutions to enable a transition to a circular economy, are briefly discussed.

6.1. Applicability of The Findings

The study is concentrated to the consumer and retail industries and one common denominator among the interviewed companies is that they are all, to some extent, active within the textile and/or the fashion industry. This might imply that the findings are applicable to others within that industry, or industries that have similar patterns in consumer demand and/or value chain. As the textile and fashion industry can be considered quite mature in meeting consumer demand with a reality of innovative and fast paced fashion cycles, it might be that the conclusions of this thesis could be applied by companies or organizations with similar goals or ambitions in the abovementioned field. On the other hand, the textile and fashion industry could also be considered immature in the control and awareness of the upstream of the supply chain, referring to the lack of information about the raw material. Marcus Bergman, Senior Consultant and Sustainability Strategist at IPM Ulricehamn, portrayed this when he stated; "The big sustainability issue in the textile industry is that the raw material industry is completely anonymized.". This discussion could imply that industries with similar maturity might be able to apply some of the findings.

Nevertheless, it is relevant to discuss the findings' applicability to other industries as well, since circular economy is gaining traction, as well as has huge potential to do so, in far more industries than just the textile- or the consumer and retail sector. In terms of the applicability of the findings to other industries, Mats Linder, Project Manager at The Ellen MacArthur Foundation, discussed in his interview how he thinks that the challenges of transitioning to a circular economy differ depending on the industry. He meant that depending on the type of product, the move towards a circular business becomes more or less difficult. This implies that the findings of the thesis would be industry specific. Furthermore, Mats Linder described it as those industries with products that are built to be robust, worth of repairing and thus already incorporate a circular thinking such as electronics, vehicles and industry machines could more easily turn to fully circular models. He also mentioned that home electronics, computers and mobiles could have great possibilities going circular due to that the value of the materials are longer than the product's lifetimes today. Also Emma Enebog, Chairman of Cradlenet emphasized the electronics industry as having huge potential going circular and in the theoretical framework, The Ellen MacArthur Foundation et al., (2015) suggested the same due to that the mobile companies and electronics have complex medium-lived products and fast moving consumer goods.

One factor that endorses the applicability of the findings to other industries is that after conducting the study, we could see that finding 8 of this thesis; Enabler: IT driven tag, is

investigated in other industries as well. The steel company SSAB, has initiated the SmartSteel- concept, which means that they incorporate data within the steel to increase transparency and traceability of the components of the material (SSAB, 2016). The reason is also to allow for knowing how to handle the product after its end-of-life. This is very much related to the findings of this thesis, even though the industry specifics and product characteristics are not very similar between fashion/textile and steel. This implies that the findings could be applicable to other industries as well. In contrast, when Fredrik Wallenholm, Associate Sustainability Analyst and Project Manager at Allies, described his current project within the furniture sector he explained that he did not think that their findings were applicable to other industries due to that the specific industry affects the companies' possibilities to transit towards circular business models. He meant that the applicability of the findings depends on the rules of the specific industry. However, Fredrik Wallenholm explicitly stated that providing labels or tags is necessary for all industries while going circular. In addition, Fredrik Wallenholm also mentioned another interesting factor, that they investigated the participating furniture companies in their study individually due to the fact that they had different business models. One might thus question whether or not the applicability of the findings of this thesis is rather connected to business model instead of industry.

To build upon this, when scrutinizing the findings of the empirical framework, several of the interviewed highlighted the need for individually developed tools to support the transition towards a circular economy and some explicitly stated that the move is different depending on business model. To exemplify, Catrine Marchall, Sustainability Manager at Stadium, said that she believes that "The circular way is the right way to go.", but she meant that because of the different business models, companies need to find their own way of reaching circularity. However, even though some of the respondents in this study had different business models, the interviews discussed similar themes. Hence, the problems with circular economy seem to have some sort of recurrence within the same industry, even if the specific companies have different business models.

The above discussion illuminates that there is no evidence that all of the findings can be applied to other industries. It can be derived that different industries face different obstacles while transitioning to a circular economy but it is also depicted that different industries see the same tool as an enabler (IT-tags) to reach a more circular economy. It is however still safe to say that the common thread characterizing the problems discussed by the interviewed in this study (lack of information) is likely to occur in other industries as well, due to the novelty of the phenomena of circular economy. To add, also those industries with similar denominators as the case studies, for example similar value chains or level of maturity could potentially benefit from considering the findings of this thesis in their move to a more circular model. How much the findings depend on specific business model and if they do is hard to predict but could be important to take in consideration when taking part of the findings of this thesis.

6.2. Possible Solutions to Enable a Transition to a Circular Economy

An interesting topic that is not analyzed in this thesis is what Mats Linder, Project manager at The Ellen MacArthur Foundation, mentions as being an enabler for the move towards a circular economy, Blockchain Technology. Mats Linder said that Blockchain could facilitate easy and trustable transactions in the value chain with full transparency, something he pinpointed as important when incorporating for example the reverse logistics. As a short introduction of the technology, Technology Trends (2016) describes Blockchain as;

> '...a type of distributed ledger, comprised of unchangeable, digitally recorded data in packages called *blocks*. These digitally recorded "blocks" of data is stored in a linear *chain*. Each block in the chain contains data (e.g. bitcoin transaction), that is cryptographically hashed. The blocks of hashed data draw upon the previous-block (which came before it) in the chain, ensuring all data in the overall "blockchain" has not been tampered with and remains unchanged.' (Technology Trends, 2016).

In this way, the Blockchain technology is a possible solution to enable circular processes since it has the potential of not only enabling trustable transactions with full transparency without the involvement of a third part, but Blockchain could also enable tracking supply chain data securely and in that way, increase transparency. This touches upon the previous analysis and the discussion of how IOT could enable more efficient flows in a circular economy. The technology is not investigated further in this research since it is a concept in itself that would require its own thesis in order to provide a comprehensive analysis of how the technology could enable a circular economy.

To build upon the discussion about IT and circular economy, Accenture and H&M Foundation predicted the trends of circular economy in fashion which showed that if clothes are connected to the internet, it could provide several benefits such as easier tracking and tracing (Olsson et al., 2017). Incorporating IOT and BigData could thus prove to have substantial benefits for the sustainability of the products and company. Having connected clothes can enable gathering information of how the product is used, as well as give information in order to educate the consumer on how to use the product in the most environmentally friendly way. Imagine being able to "communicate" with the customer through the product. It could facilitate the transition to a more circular economy if the right communication to the customer could be achieved. This is a topic that was highlighted during our thesis at TechniaTranscat and recently a project was initiated regarding this area at one of the Joint Ventures, the IOT company OptimData, where Addnode has a stake.

7. Conclusion

This thesis showed that businesses need to accelerate the transition to a more sustainable setting. It also found that circular economy is gaining traction within the consumer and retail industry and that the transition has already begun. It was concluded that the change requires changed business processes within the product Lifecycle but the report also depicted that the IT systems do not support these changes in a satisfying way today. The relevance of finding enablers was thus high, endorsing the aim of the study. In order to answer the research question of how a PLM system can enable more circular models, the thesis depicted that the most stressing issue with the transition, relating to the processes within the product Lifecycle, was the lack of reliable sustainability information to base decisions on. In a circular scenario, the lack of information was depicted to result in problems especially within the design phase and within the end-of-life phase. The consequence of not having the right reliable sustainability information in the design phase were outlined to be; uninformed decisions, lack of transparency, impeded circular design and lack of knowledge of environmental impact. The consequences in the end-of-life phase were; impeded circular design and lack of knowledge in how to handle the recollected products. The enablers that would improve the availability of sustainability information in these phases were analyzed to be; sustainability index and/or scorecards, and IT driven tags, portrayed in table 7.1.

Table 7.1. The table presents the three enablers that could be incorporated in a PLM system and in that way, facilitate circular business processes.

Enablers	
Sustainability Index	Gives reliable sustainability information in the design phase In fashion: The Higg Index is the most widespread and predicted to be the most used in the future Enables informed decisions in the design phase Enables circular design
Scorecards	Measures different sustainability aspects Enables informed decisions in the design phase Need to be adapted to the specific business and its product's specifications Need to incorporate metrics that measures the total Lifecycle of the product, birth to end-of-life
IT Driven Tag	Tracks and traces the location, status and information of the product. Enables efficient reverse logistics processes Enables circular design

Incorporating the mentioned tools within the PLM system would also allow for increased transparency of the business, decreased complexity of using the tools, only using one system for gathering all the data related to the product Lifecycle, transforming business-as-usual operations as well as it would provide know-how to the user of the system. Moreover, using the three suggested tools within a PLM system would also facilitate connecting the information gathered in different phases, using it to provide a holistic, easy to use system and improve the product from the birth and adjust it to its end-of-life. It is concluded that the three tools do not necessarily need to be integrated within the PLM together or at the same time, but they could create more value together than if used individually. On this note, an important finding of the thesis was that solutions related to the problems within the birth of the products and its afterlife seemed to be closely related and in fact interlinked. Thus, a successful

transition towards a circular model requires a holistic view of the total sustainability of the product, from birth to afterlife. Conclusively, as previously mentioned, in a circular scenario one cannot simply consider the birth of life without considering the end-of-life and vice versa.

This study showed that the circular economy is on its way, especially within textile and fashion. It is concluded that when the tools enabling a circular economy are available, fashion and textile is an industry that will use them. Moreover, the findings also indicated that circular economy is starting to spread among other industries, as well as in politics and in research. All this implies that PLM providers need to gather knowledge and skills in a circular economy in order to stay ajour and meet the demands of their customers. However, merely incorporating the abovementioned tools in PLM could not solve all issues related to the transition to a circular economy. It was evident in the report that the move towards a circular economy depends on several other enabling conditions than only incorporating tools within the PLM. The thesis depicted the additional barriers towards transitioning to a circular economy to be policies, changed consumer habits, culture in the company and change management, new measurements and KPIs, investments and risk management. Figure 7.1 illustrates the findings of the thesis.

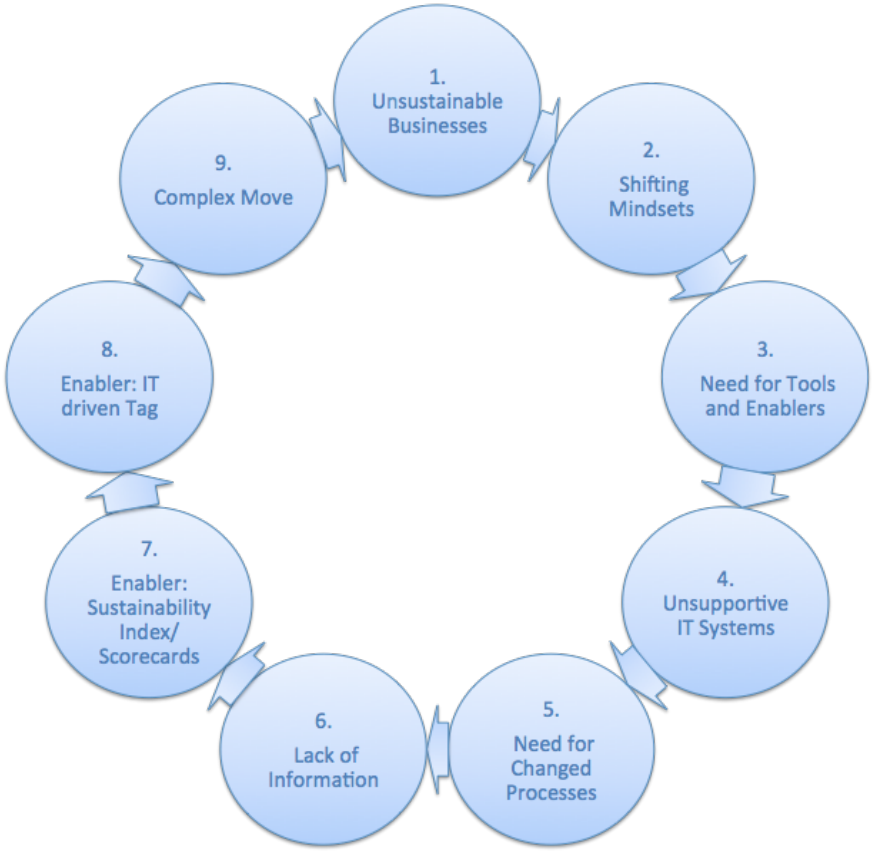

Figure 7.1. The figure illustrates the overall findings of the thesis. The findings are represented in the figure with arrows and numbers for easier illustration. However, it does not necessarily mean that the findings depend on the former, that they are chronologically ordered nor does the number indicate the level of importance.

8. Demarcations and Reliability

The report investigated the transition towards a completely new way of doing business, thus the area in question is a wide and complex concept with a lot of different hinders and barriers affecting the move. However, the thesis focused on one enabling condition, the PLM system. As the analysis and discussion denoted, it is evident that several other enabling conditions are necessary, except the PLM system. Still, the novelty of the phenomena of circular economy and the ongoing transition implies that it is time to start investigate how to enable the move and this thesis takes on a small step towards that, by solely investigating how the PLM system can facilitate the transition. The thesis however lacks investigation of the integration with PLM and other types of systems, how those specific systems might enable the move as well as how to implement the tools within the systems. Furthermore, it could be argued that the thesis takes on a rather positive view towards a circular economy and includes no criticism towards the concept in itself (even though it still highlights the obstacles it bears with). On that note, the relevance of changing the way we consume and produce and the lack of alternative "competing" concepts to circular economy indicates why there is no comparison or criticism towards the concept. Some might also criticize and question how realistic it is to try to change the linear model that has historically been prosperous in terms of economic growth on a global level. We agree with Stuchtey et. al (2016) in this discussion;

> "After all, isn't it both unrealistic and cynical to suggest deep changes to a growth model that has in many ways served us so well over the last decades, and in which we are so massively invested? We chose to provide this alternative vision anyway, because it is so clear that thinking around the edges of the current growth model will not get us anywhere close to our ultimate goal. When it comes to resource-related parts of our economy, we need a deep redesign." (Stuchtey et. al 2016, p.4).

It could also be discussed whether or not the companies taking part in this thesis actually do all they say regarding environmental and circular economy aspects. Since CSR historically has been and still is, a part of businesses' PR, this could be an area that suffers from over-exaggerations and publicity stunts. It could thus be questioned how well the statements made by the companies in the interviews are followed through in practice. The fact that some of the data gathered is based on archives makes the information presented in this thesis somewhat more reliable and realistic. In addition, as mentioned in the method section of this thesis, the persons interviewed representing a company, were involved in sustainability and not in the IT department. This implied that the data gathered could be inhibited in relation to the knowledge of the IT system and its functions. The knowledge gap that was visible in some companies could imply that they would find it harder to move towards more circular business processes by the use of an IT system since it is required that those working with the system understands it. The fact that we noticed a knowledge gap in how the IT system is used, indicates that the IT system should be integrated more into the daily processes over all

functions (also the sustainability function) and that this becomes especially important in a circular scenario since there will be more data and information to consider for all involved, creating a stronger need for an efficient IT system that will and can be used by all stakeholders.

Moreover, as marked in the discussion, the findings are derived from a study of companies within consumer and retail, all somewhat active within textile, but with different ways of doing business, impeding the generic applicability of the solutions. Another demarcation is that only the design and end-of-life phase were investigated since the findings of the study implied that the design of the product and the end-of-life of the product were the two phases in the product Lifecycle most important to consider in the transition towards a circular economy. Important to add, is that other phases in the product Lifecycle are necessary to consider but under the conditions for this thesis had to be excluded from the analysis. On a final note, all the barriers towards the transition to a circular economy that were discussed during the interviews are not presented in this thesis.

9. Future Research

The suggestions for future research are many in regards to the novelty of the phenomena of circular economy, the many hinders that need to be overcome, the complexity of disrupting the current economic model as well as the lacking number of case studies on the topic. A next step based on this thesis would be to investigate the integration with PLM and other types of systems, how those specific systems might enable the move as well as how to implement the tools within the system/systems. While looking at the transition in a wider perspective, also the barriers and hinders outside the IT system's range that were not analyzed further in this thesis need to be overcome in order to realize the circular economy and would thus benefit from further research. As one example, relating to the barrier of consumer habits, it would be interesting to switch lenses and investigate the issue from the consumer standpoint and focus on how the transition could be enabled or facilitated in society and among individuals. On this topic, it would be intriguing to dig into what Lewis Perkins, President at Cradle to Cradle Product Innovation Institute, mentioned in his interview. He said that technology and gamification could be used to incentivize the consumer to change habits. Thus, investigating how technology and circular economy could create value together from the consumer perspective adds to the list of exciting and important topics to research.

In addition, as highlighted in the discussion there are several other enabling technologies and conditions that were not analyzed in this thesis and would be highly interesting to investigate further such as Blockchain and connected products. To build upon this, it would be of interest to study how the issues of transparency in value chains could potentially be solved. Moreover, conducting a similar investigation as the one at hand but focusing on another industry and/or industries, than the consumer and retail, is needed today in regards to the many industries that need to change the way they produce and sell their products and thus need tools and enablers to achieve the transition. As a suggestion, the industries that are highlighted in this thesis as having great potential of switching to a circular economy but needs changes within the existing structure, such as electronics and the construction industry, would be relevant areas to research. Furthermore, when considering the fact that the sustainability awareness seems to be on different levels depending on country, or part of the world, it would be of interest to investigate other parts of the world regarding similar questions as those raised in this thesis.

One interesting observation is that Company X was only mentioned in the analysis in one section. It is evident that they as a company have not yet started incorporating the circular economy nor have they started to think in the same way as the other interviewed companies. The reasons for why are probably many and could be impossible to prophesy, however interesting to investigate further. Company X differentiates from the other interviewed companies since they are the only company that is active within electronics and has a wide product range where textiles are not the main focus as is the case for the other respondents in this thesis. It would be interesting to investigate if there is a correlation with companies

similar to company X in how far they have come in incorporating thoughts around circular economy in their business and if it differs from the textile companies.

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Appendix

The appendix shows the interviewed experts' background and experience related to sustainability and circular economy.

1. Bang, Erik - Program Manager at H&M Foundation

The H&M Foundation is a non-profit foundation privately funded by the founder of H&M (H&M Foundation, 2017a). Its mission is to drive long lasting positive change and improve living conditions by investing in people, communities and innovative ideas (ibid). They work with sustainability questions in the fields of education, water, equality and planet, involved in several partnerships with organizations around the world (ibid).

Bang is in charge of The Global Change Award. A competition that aims to spur the shift towards a circular and sustainable fashion industry by collecting the most innovative ideas in the world (H&M Foundation, 2017b).

Bang previously worked as a Project Manager at the International Council of Swedish Industry who supports Swedish businesses in politically, economically or socially complex markets. Has also been a Member of the Board of Directors at The Swedish North African Chamber of Commerce and has an educational background within political science.

2. Bergman, Marcus - Senior Consultant and Sustainability Strategist at IPM Ulricehamn

IPM Ulricehamn is a strategic communication agency that offers consultancy within business development (IPM Ulricehamn, 2017). Bergman is here focused on creating sustainable brands (ibid).

Bergman has worked with sustainability since 1998 in Sweden, Turkey, China, India and Bangladesh. Previously been head of sustainability at Gina Tricot. Is a renowned communicator and lecturer within sustainability. A published writer for daily- and design-press as well as a chronicler in Sweden's Radio. Is currently arranging a course within sustainability/circular economy in Fashion, at Borås University.

Educational background in International Relations and Human Technology.

3. Enebog, Emma – Chairman of Cradlenet

Cradlenet is a nonprofit organization and cross-sectoral network promoting circular economy in Sweden (Cradlenet, 2017a). Has both companies, organizations and private people as members (ibid).

Enebog is currently Head of Sustainability at the second-hand chain Myrorna. Previously worked at Fairtrade Organization as Project Leader and Secretary General. Has been part of The Nordic Council of Ministers who developed the first certification for collecting textiles.

Educational background in Environmental Science.

4. Larsson, Jonas – Associate Professor

Associate professor in Textile Management at Borås University of Textile. Conducts research in demand driven systems for local manufacturing, mass customization, circular economies and apparel and textiles within the planetary boundaries. Is responsible for Borås University's involvement within the Sustainable Apparel Coalition. Created the Master Program Textile Management, with specialization in Textile Value Chains and Fashion Management.

Larssoon conducted a treatise within Mass Customized Fashion, investigating a more sustainable fashion industry. Is an expert member of Euratex Groups with focus on close loop manufacturing of apparel and textiles and Lifecycle management.

5. Linder, Mats – Project Manager at The Ellen MacArthur Foundation

The Ellen MacArthur Foundation was founded in 2010 with the mission to accelerate the transition to a circular economy (Ellen MacArthur Foundation, 2017). The Foundation is today a global thought leader, promoting circular economy together with business, government and academia (ibid). The charity started in 2010 and is supported by SUN and MAVA and partners with Arup, IDEO, McKinsey & Company and SYSTEMIQ (ibid).

Linder was a member of the project and resulting report; Delivering a Circular Economy: A Toolkit For Policy Makers (2015), which included a blueprint for stimulating the transition towards a circular economy for policy makers, as well as project leader for the research; Intelligent Assets: Unlocking The Circular Economy Potential (2016), which investigated how IOT and circular economy can create value together.

Previously worked as a consultant at McKinsey & Company and has a PhD from KTH within physical chemistry.

6. Perkins, Lewis – President at Cradle to Cradle Product Innovation Institute

The Cradle to Cradle Products Innovation Institute's mission is to guide and educate product manufacturers and designers to make safe and healthy products and become a positive force for society and the environment (C2C-Centre, 2017a; C2C-Centre, 2017b). In 2010, the institute formed the Cradle to Cradle Certified Product Standard, an assessment and a rating system for products based on five categories; safe and appropriately sourced materials, material reutilization, renewable energy and carbon management, clean water stewardship, and social fairness (C2C-Centre, 2017b).

Perkins currently works on an extended part of the standard, a platform for chemical assessment. The platform will work as an assessment tool for human and environmental impacts of chemicals, improving the decisions in the design phase of a product. He is one of the jury members in H&M Foundation's circular economy competition, Global Change Award.

Perkins previously worked as a sustainability strategist at New House, LCC, where he developed and implemented visionary strategies for Fortune 500 companies. Before that, as part of a long list of accomplishments, he founded and co-authored a book project with Laura Turner Seydel where they collected inspiration stories of people making a change for the planet. Has an MBA in marketing and a BA in art history and business.

7. Wallenholm, Fredrik – Associate Sustainability Analyst and Project Manager at Allies

Allies AB, part of Business Wellness Group (Centigo AB) is a consulting firm assisting in creating healthy organisations with a positive impact on social, ecological and economic development (Allies, 2017).

Wallenholm is included in the research and executive group of the Vinnova-funded (Swedish state) applied research project regarding circular business models for Swedish furniture manufacturers, where he is active in parts regarding customer insight, service design, product design, production, business models and brand strategy.

Wallenholm is also Project Manager brand- and product development, strategic alliances, where he takes on cases helping Swedish manufacturing companies use sustainable design. Is also Senior Advisor for market research and analysis projects where he has conducted approximately 200 projects, freelance.

Educational background in the fields of sustainable consumption, sustainable design and sustainable development.

8. Moro, Marco – Editorial Director at Renewable Matter

Renewable Matter is an international magazine about the changing relationships between economy, society and environment. Focuses on bio economy, circular economy, green and blue economy as well as sharing economy (Renewable Matter, 2017).

Moro previously worked as Editorial Director at Edizioni Ambiente (Environment Issues). Also worked as Communication Manager at ANAB National Association. Educational background in Communication Design.